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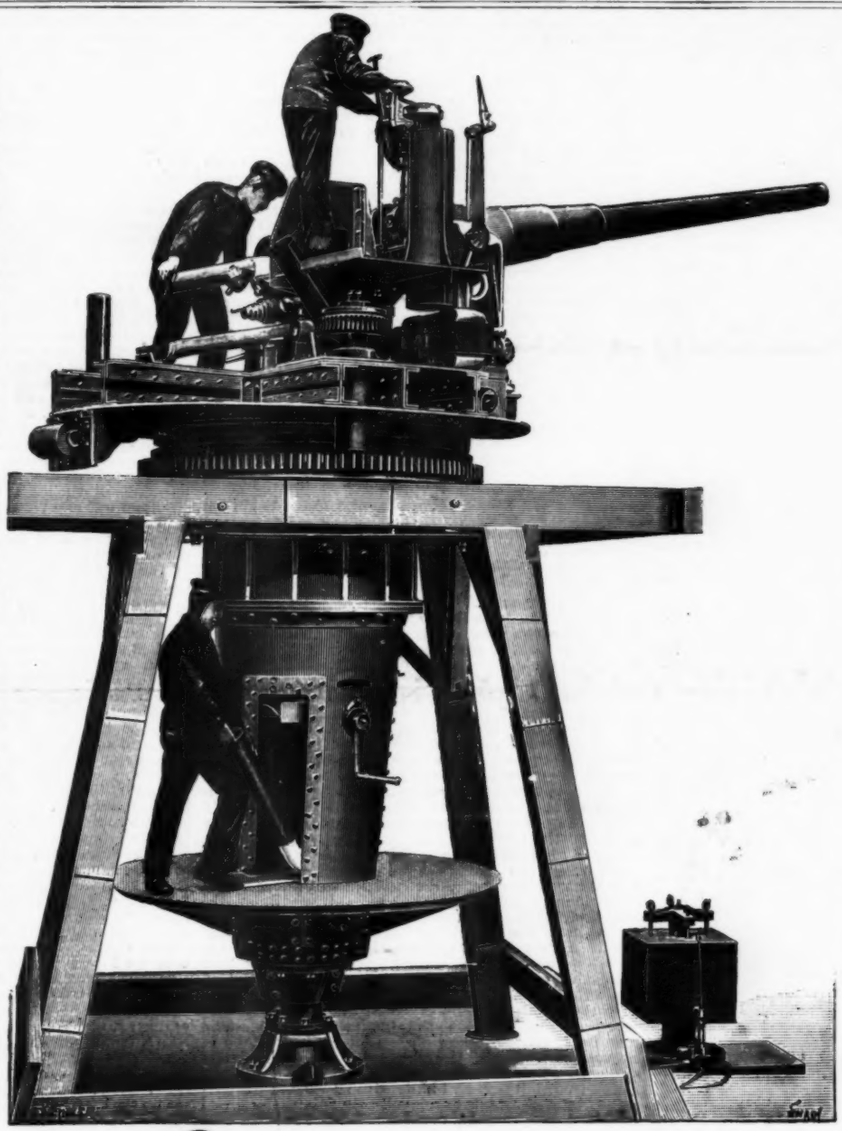
CANET ELECTRIC TURRETS.

WE may say, says the Engineer, in introducing the following brief description of the newest patterns of Canet electric worked turrets, which we have obtained from the manufacturers, that the general principles said to characterize the working of French turrets are alternative hand gear, the provision of automatic return of all lever handles to their original place directly they are released by means of counterweights; and the provision of safety gear, so as to guard against all mistakes and accidents as far as possible in action. In the hydraulic working the rotation of the turret is generally effected by a simple application of chains and hydraulic cylinders. It may be seen that the same general principles are kept in view in the electric system of Canet, in which the French government has taken the lead of England. Our own Powerful and Terrible have barbette mountings for 9·2 in. guns worked by electricity, which appear to be excellent, but the ships will not be in commission for some time to come.

The Société des Forges et Chantiers de la Mediterranée have turned out or have now in progress nearly forty turrets worked by electricity for the Latouche-Tréville, the Jaure'guiberry, the D'Entrecasteaux, the Pothuau, the St. Louis, the Capitan Prat, the Skjold and the Carlos V.

Those last completed, which have embodied in them the newest improvements, are for the Danish coast defense ship Skjold. The work supplied includes (1) one Canet turret for a 24 cm. gun, (2) three Canet turrets for 12 cm. guns. These are closed turrets, and, as in all others of the same type, the electric gear is supplemented by alternative hand gear, with provision for instantly changing by means of switches from one system to the other. In the 24 cm. gun turret electric working is applied to laying the gun and also to raising the ammunition. In the 12 cm. turrets it is applied only to laying the gun. In the latter hand gear provides such efficiency and speed that there is no necessity for having recourse to an electric motor.

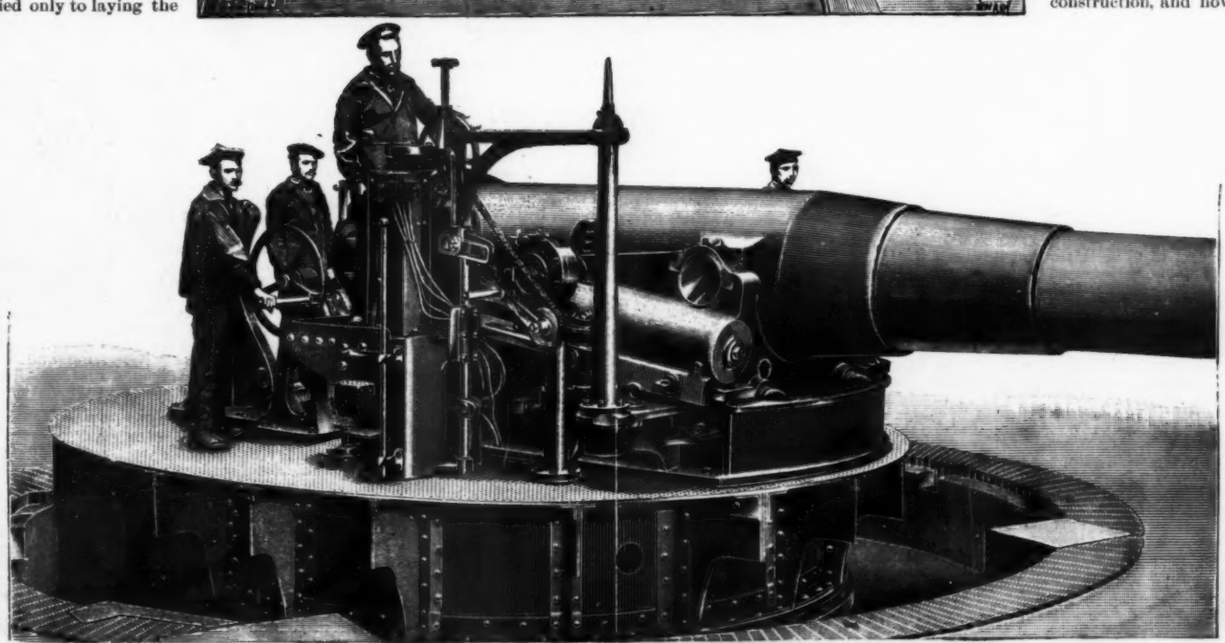


The electric apparatus for laying the gun is of the type known as the "cartouche electrique" type. Excellent results, we are told, were obtained with this system on the Latouche-Tréville, and these have been entirely confirmed by trials which took place at Havre in the presence of the Danish commission, and which have given prominence again to the great accuracy with which laying can be performed by the use of the "cartouche electrique," identified with the names Canet, Hillairet and Hugnet. Not only has the captain of the gun complete control throughout, whatever may be the velocity of rotation of the turret, so that he can stop it dead, but also in laying he can at will, in either direction, make corrections less than the fortieth of a degree. These trials have been repeated many times before a great number of officers.

Thanks to the special arrangements which characterize the Canet turret system, and to the adjustment of weight, the work necessary to give rotation to the running weight is reduced to a minimum. Thus for the motor for rotation of the turret of the 24 cm. gun, the nominal power is 15 horse power, and hardly two-thirds of this amount is ordinarily required. For the rotation of the turret of the 12 cm. gun a motor of 3 horse power is sufficient.

The ammunition hoist of the 24 cm. gun turret is worked by a motor of 8 horse power. It is controlled by a commutator of a special kind, provided with automatic return to either end of its range, and with special safety arrangements to prevent the possibility of accident.

The engravings show the general arrangements of the turrets. No attempt is here made to give a lengthened description in detail. A report on these turrets has been made at the request of M. Neilson, formerly director of construction, and now direc-



CANET ELECTRIC TURRETS FOR THE DANISH WARSHIP SKJOLD.

tor of the dockyards of Burmeister and Wain at Copenhagen. The Danish commission intrusted with the testing and acceptance trials at Havre consisted of MM. Schwanenflugel and Rasmutten. The president of the French republic was present at the trials, and himself worked the 24 cm. turret.

[Continued from SUPPLEMENT, No. 1049, page 16773.]

CLASSIC ARCHITECTURE.*

FROM THE POINT OF VIEW OF AN ARCHITECT. A DISCOURSE BEFORE JOHNS HOPKINS UNIVERSITY, AT BALTIMORE, MD.

WHEN the Romans forced their political system on all the outlying nations of Europe, Asia and Africa, their architecture was cultivated less for its own sake than to serve as a visible sign to the barbarians of the power and magnificence of the empire. It was employed less to civilize or refine than to astonish and overawe. But in the conquest of Greece they received far more than they gave. The conquerors were themselves conquered by the supreme beauty of Hellenic arts and letters. Among the spoils of war which came to them from this conquest was the fully developed flower of the Doric and Ionic styles. This flower, however, they could not appropriate as a living thing, but only as a symbol; it was far too delicate and sensitive to bear transplanting in a soil so coarse and strong as that of Rome without some very essential changes in its character. The Romans could make the Greek artists their slaves, but they could not control the peculiar creative instinct of their captives; indeed, this instinct could not continue its happy development under these new conditions. The serene atmosphere, the contemplative silence, the simplicity of life, the sympathy of the people, the intellectual exaltation, which had made this growth possible in Attica, which had also made possible the Iliad, the Œdipus Tyrannus, the Panathenaic frieze, were all wanting. The impatient ambition of Rome, her ostentatious splendor, her desire for magnificence rather than beauty, furnished new motives of design. The living organism of the Greek Doric and Ionic styles was little suited to meet these new political and social requirements, and it was found necessary to formulate them and to subject their details and proportions to rules more or less inflexible, so that they could be put to use without inconvenient delay. The delicately studied curves of the Greek mouldings were supplanted by mouldings which could be readily struck with the compass. In this way the Greek styles became Roman orders of architecture and in effect a part of the vast administrative machinery of the empire. Practically its buildings were decorated according to official formulas to represent the overwhelming power and wealth of the state.

To these orders the Romans added three more, peculiarly their own—the Tuscan, the Corinthian and the Composite. The Tuscan was a development from the ancient art of Etruria, and was therefore in the main indigenous to the Italian peninsula. It differed from the Roman Doric mainly in detail only, and the principal features of the two orders were frequently interchanged. It was adapted generally to buildings of severe utility, and received little, if any, decoration. But the Corinthian order had its origin in Greece, where it never passed beyond the experimental stage. In the land of its birth, it was a variation of the Greek Ionic applied mainly to the capital. This feature in its original form consisted of a concave calyx or basket-shaped cap, borrowed from the Egyptians, but incased not with the lotus or papyrus leaves of the Nile, but with a conventionalized form of the leaf of the wild growing acanthus of Attica, arranged vertically around the calyx. From these sprang four Ionic volutes, like horns, supporting the corners of the square abacus above. Its most highly developed form in Greece appeared in some interior columns of the Temple of Apollo, near Miletos, and in the little Choragic monument of Lysicrates at Athens, which latter may perhaps be considered the prototype of the Roman Corinthian. Following this prototype a Roman architect, Cossutius, who had been sent to Athens to complete his professional education, designed the capitals of the great Temple of Olympian Zeus, at Athens, which was scarcely completed when Sulla transported them to Rome about 84 years B. C., where they were used in the temple of Jupiter Capitolinus. From this beginning the Corinthian order of Rome speedily developed. Nothing could have been better fitted than this order to express the magnificence and luxury of the empire. All the other orders contributed to make sumptuous, and when its various features and proportions had been finally formulated, according to the Roman manner, it represented the very highest and most characteristic expression of Roman art. It appeared not only in the most splendid monuments of the capital, but, lavishly reproduced in the remotest provinces in great religious and civic buildings, it fascinated the barbarians and confirmed the rule of their conquerors. From the earliest years of the Christian era to the present day the ingenuity of mankind has been spent upon the inexhaustible theme of the Corinthian capital with infinite variation. The carvers of Byzantium and Ravenna, the Gothic sculptors of the middle ages, and all the architects of the Renaissance have worked upon it. It was Christianized in the cathedrals; it was restored to paganism in the Renaissance. All the leafage and flora of nature were applied to its bell to express the genius of successive races in history. Possibly when the capitals of the temple of Capitoline Jove were in the progress of civilization through the centuries repeated in St. Peter's of Rome, in St. Paul's of London, in the Pantheon of Paris, in the Capitol of Washington, as they will continue to be repeated in some form or other in the great monuments of the future, either the doctrine of the survival of the fittest or the poverty of the creative powers of man found its most complete demonstration. As for the Roman Composite order, so called, it was a mere debasement of the Corinthian, it was never distinctly formulated, and it seems to express, not order, but disorder and the license of luxury.

But the most important and most characteristic contribution of the classic architecture of Rome to the artistic resources of the world was not in these five orders, but in the invention of the arch and of its direct derivatives, the vaulted roof and the dome. No invention of men, except, possibly, that of the steel beam and plate glass in modern times, has exercised so great an influence over all subsequent architecture. By virtue of this great discovery, the Hypostyle Hall of Karnac, on the Nile, filled with the enormous bulk of its columns, the narrow Parthenon with its nave and aisles, and all the ancient roofed monuments, which were necessarily restricted in width by the limitations of a trabeated construction, gave place to the vast open spaces majestically covered by the intersecting vaulting over the halls of the imperial baths and basilicas, and by the dome of the Roman Pantheon. It made great open interior dimensions possible in architecture. It substituted arcades for colonnades, and gave birth to the science of engineering and to extensive works of public utility until then impossible.

The first development of the principle of the arch in roof construction consisted in the barrel or wagon vault, which was a continuous arch thrown over the space between two parallel walls. Areas of considerable width could thus be covered with permanent curved ceilings, composed of small cut stones fitted together, or with cement concrete laid over a temporary form or centering of wood, which was removed when the work was finished. This was the first substitute for ceilings composed of a series of long transverse stone beams, having a bearing at the ends on opposite columns or walls, as was the case with the ceilings of the peristyles surrounding the Greek temples, and with those covering the narrow aisles in the great halls of Egypt; or for the roofs of wood, which were thrown over the wider central areas of all the pre-Roman buildings. But the primitive barrel vaults of the Romans presented a serious difficulty of construction, as they required a cumbersome and brutal massiveness in the continuous supporting walls, and practically limited the width of the areas to be so covered. The system was thus an obstacle to that free lateral extension which the requirements of the public service in Roman civilization rendered essential in the plans of monumental buildings. It was a political and social necessity, therefore, not a sentiment, which inspired the next step in the structural development of architecture. This requirement for indefinite lateral extension suggested the idea of crossing the original longitudinal barrel vault with transverse barrel vaults of the same width, making it practicable to cut great arches through the supporting walls, or, in fact, to reduce them to a series of isolated piers, upon which the great weight of the arched ceiling, or quadripartite vault, as it was called, could be concentrated. Heavy continuous walls thus became structurally unnecessary and were only needed in lighter form for closures and partitions.

Architecture was thus emancipated from the strict structural conditions which had confined the development of form in Greece and which had made it necessary for the Greek artist to concentrate his creative energy on the decorative evolution of buildings of the most primitive character, like the cella of their temples. This concentration of power made possible the consummation of the Parthenon, beyond which the Greek evolution could not go in its characteristic national development. A corresponding consummation was not practicable among the Romans, not only because they had rather the practical than the æsthetic sense, but because their creative powers were dissipated over a field of effort which had been indefinitely extended by the consequences of the discovery of the quadripartite vault.

The Greek idea of closure did not go beyond a cell or small room, the plan of which was a parallelogram. The Roman idea embraced an indefinite series of rooms of various dimensions in height, width and length, having definite structural relations one with the other.

This indefinite complex of rooms of great horizontal extent suggested to the Roman builders the provision of vistas and the establishment of center lines. The plan being thus at length freed from the domination of a structure of limited capacity, assumed for the first time that primary importance in every architectural scheme which it has maintained to this day. The plan being settled according to conditions of use and convenience, the visible architecture resulted logically and with comparatively little effort. They could surround their lofty central halls with subordinate apartments vaulted at a lower level. By this variation of height they were enabled to secure light for the central halls by high arched windows, thus introducing the clerestory into the architectural scheme. In this way, by a perfectly reasonable process, the Romans developed exterior effects of great variety in height and horizontal extent.

In the whole complicated composition they learned how to preserve unity in variety; how to group the various parts so as to provide for a symmetrical balance of masses, with proper culminations. Their work was always done with dignity and order and with a perfection of construction which in many instances has survived, not only the natural vicissitudes of time, but the terrors of political convulsions through more than twenty centuries. Their enormous halls are majestic and imposing even in ruins, and the vast extent and the imperial dignity of their baths and aqueducts, their palaces and villas, their forums and basilicas, their circuses and theaters, their triumphal arches and bridges, their temples and tombs, are still evident not only in Italy, but in the remotest provinces of the empire, nay, even in the almost inaccessible deserts of North Africa; so that we can readily comprehend how, when these structures were in their glory, the barbarians submitted to a power visibly expressed in monuments so stupendous and overpowering, not only in the massive character of their structures, but in the lavish splendor of their adornments.

The most majestic and architecturally the most imposing and effective development of Roman vaulting was in its adaptation to their circular halls, such as occurred in the baths of Caracalla and Agrippa, the latter being now known as the Rotunda of the Pantheon. If the complex structure of the great Roman monuments permitted any such logical culmination as was achieved by the Greeks in the Parthenon, it would undoubtedly be found in the ingenious construction, in the gracious simplicity, in the overwhelming majesty, of this the first and perhaps the most successful of the great domes in the history of architecture. Measured by its influence on all subsequent architecture, it must take rank as one of the most important monuments in the world. The conception of it was a great architectural thought, and it was entirely Roman. From it was derived another conspicuous feature of Roman architecture, the half-dome or conch, which covered the semicircular projections of the great chambers of the baths and more especially of the basilicas or courts of justice, in which position they became the prototype of the Christian apse or chevet in the cathedrals.

It must be admitted that Roman vaulting, especially when used on a monumental scale over the great halls of their baths and basilicas, was a development rather from the form than from the construction of the arch. For in such cases it was constructed, not with shaped stones, but with a concrete of Roman cement and tufa or pumice stone, filled in solid over the vault, which was rarely less than six feet thick in the thinnest part. It was thus a homogeneous mass exercising little or no thrust upon the walls and piers, but bearing upon them vertically like a huge hollowed monolith. But, however constructed, we cannot avoid the conclusion that the various forms of vaulting vitally affected or controlled the plans as well as the outward and inward aspects of the Roman building. In fact, they imposed upon it fundamental laws of dimension, shape, and proportion, before the architects dreamed of decorating it.

This point opens to us a very important and very curious fact in the history of Roman architecture. We have seen that Greek architecture was not something imposed upon structure; it was structure itself, decorated and elevated into a fine art by the genius of a great race. The architecture cannot be removed without destroying the fabric itself. The arch, the vault, and the dome of the Roman builders were as capable of characteristic elevation into the domain of high art as the post and lintel of the Greeks. But this construction never received such a development at the hands of the ancient Romans. It was the early Christians who first gave to this structure its own proper decoration at Byzantium, at Ravenna, at Rome, at Venice, at Pisa, at Milan, in Southern France, and wherever else that form of art known in its earlier developments as Byzantine and in its later developments as Romanesque, took shape and prepared the way for Gothic architecture. Indeed, the structural principle of the arch was first developed into true architectural expressions, not by the Greek architects, who worked at Rome under pagan masters, but by the descendants of those Greek architects, the men who worked in Byzantium several centuries afterward in the perfect freedom of Christianity and under Christian inspirations.

We have seen that the Romans borrowed the forms of Greek art and formulated them into the five orders of Roman architecture. But these orders rarely were applied structurally as in Greece. In Roman temples, which were by no means the most characteristic expressions of Roman art, in the colonnades of the forums, in the porticoes of the basilicas and palaces, the Roman orders appeared in the proper functions as decorated construction. But the most characteristic and by far the most common form of Roman structure was dictated by the arch, the vault, and the dome. We have seen that these features were invented by the Romans in order to make possible the kind of buildings which were needed by their political and social system. But it was a part of this system that these buildings should not only be orderly in their arrangement, enormous in extent, durable in construction, economical in administration, but also magnificent in adornment. To the Romans, art was necessary to the embellishment of life, but it was to them a secondary, not a primary consideration, and it entered into their ideas of building, not as an integral element, but as an afterthought. If it had been an integral element of those ideas, the noblest productions of the Romanesque period would have been anticipated and almost infinitely expanded by the Romans themselves and certainly the whole course of the art of the Renaissance would have been turned into some unknown and unimaginable path of structural beauty and power. Under these conditions the Græco-Roman orders presented themselves as convenient decorative formulas, the absolute fitness and propriety of which had been justified by the practice of a race recognized by the Romans as far more advanced in literature and art than themselves. So when the question arose how their native system of arches, vaults, and piers was to be decorated, they applied to them these ready-made formulas as a decoration entirely independent of construction; and all the subsequent developments of the classic orders of architecture down to our own day have in like manner been entirely independent of construction. Against the piers which supported the vaulted roofs of their basilicas and of their great halls in their palaces and public baths, they placed as decorations fragments of their orders, a column supporting a block with the mouldings of a full entablature, from this sprang the arched construction of the ceiling. They did not think of decorating the pier itself according to its structural functions. They enveloped the whole interior surface of walls with pilasters and entablatures according to the official formulas, executed in the most sumptuous manner with precious marbles and capitals of gilded bronze. They used the exact orders as open screens in the separations of these rooms. All this arbitrary veneering and furnishing was done with great splendor and infinite skill of adaptation. But while the remains of the essential structure of those great vaulted buildings still rear themselves between the hills of Rome, this splendid veneering has long since disappeared.

But by far the most characteristic and important use of the classic orders by the Romans as decorative adjuncts was in their exterior walls. They were so prepossessed by the idea that the Greek styles were necessary to all architectural effects, and, in fact, constituted architecture, that they did not think of decorating their own noble and beautiful system of arcuated and vaulted structure, thus creating a legitimate Roman style, but considered that it could not be made architecture without the aid of these styles. They, therefore, forced their version of them in the form of Roman orders, illogically and without mean-

* By Henry Van Brunt, Kansas City Architect and Builder.

ing, into the construction of their walls. They either set the full column in front of their walls like a buttress, supporting a block of entablature, but doing no constructive work, as in their triumphal arches, or they built the columns into the structure of the wall for half their diameter—engaged them, as it is called—in which position they usually supported a continuous entablature, as in the temple of Fortuna Virilis. This latter use of the order was perhaps imitated from an isolated and exceptional example of a similar structure of the Greeks in the great temple of Zeus at Agrigentum, or, more probably, in the little choragic monument of Lysicrates at Athens, before referred to. But as these engaging columns necessitated a costly overhanging entablature, they invented, or adapted from the Greek anta, a flat column or pilaster, which was used most profusely in every Roman monument which had any claim to decorative or architectural character. Between these decorative engaged columns or pilasters occurred the structural arches of the Romans, which alone did the essential work of the walls. In their many-storied buildings, like the theater of Marcellus or the Flavian amphitheater, they superimposed these orders or expressions of orders, placing the most robust, as the Tuscan or Doric, at the base, the Ionic in the second range, and the Corinthian in the third as the most appropriate decorative culmination of the composition. This superimposition introduced new formulas of proportion applicable to the mutual relations of the orders when so grouped. The successive stories were structurally arcades, the horizontal entablatures or string courses between these arcades expressing the floors, and the pilasters or columns standing for the expression of vertical support in the piers between the arches.

This is the Roman system of decorative wall architecture, which was supplanted by a logical and legitimate expression of pure arched construction in Romanesque art without the use of the unnecessary orders, which, after the mediæval period, was restored to full power in the architecture of the Renaissance, where it was so refined by the immortal masters of the fifteenth century in Italy, and so enlarged in its scope by those of the sixteenth century in France, that modern art has received it as a canonical tradition of architecture, and, in some form or other, repeated the insistant motive in nearly all the Renaissance monuments of the world, but with astonishing variation of detail and ornament. In these variations the genius of every civilized people in the world has expressed itself; even the character of reigning monarchs, as it affected their courts, affected the mixed Roman system of arches and orders which they had inherited from their predecessors; so that, made venerable and precious by these accretions, it has now all the value of a historical record of the various stages of the progress of mankind in civilization; as such, irrespective of its want of structural character, it has become a highly organized and extremely copious language of forms.

It is important to note that in this progress of the mixed Roman system of arches and orders through history the formulas of proportions and details fixed by Rome and confirmed by the Italian masters have been respected in exact accordance with the degree of culture and artistic feeling existing among the people using it. Wherever these formulas have been disregarded, this system has been debased or travestied, and every such debasement is a sure indication of a corresponding debasement in civilization.

When the Roman empire was declining to its fall the canonical forms of architecture, established by the best usage of imperial times and requiring a certain virtue of artistic discipline to maintain them in purity, experienced a corresponding decline. Among the changes, more or less capricious and disloyal, which were suffered by these forms, was one of such pre-eminent importance in its effect upon subsequent architecture that it seems necessary to consider it here.

One of the most conspicuous monuments of this period of decline was the immense palace built by Diocletian, after his retirement from the cares of empire, at Spalatro, on the eastern shore of the Adriatic. At this time the authority of official Roman architecture had been so far relaxed that certain free and romantic elements had been permitted to enter into the design of the public monuments. This relaxation of discipline was contemporaneous with and expressive of the failing strength of the Roman state, and affected not only the details, in a certain loss of refinement, but some of the most important and hitherto most absolute features of the orders. During the period of authority, every Roman arch sprang from an impost or horizontal moulding, very subordinate to the members of the order which was engaged in the wall surface, or, if the arch was very large, from the entablature of the order itself, as in the great arches of the imperial baths and basilicas, or in the interior of the walls of the Pantheon, according to the most authentic restorations. They could not conceive a column without its own entablature. But at Spalatro, among other variations from the official types, the arch was permitted to spring for the first time directly from the capitals of the columns. This change seems very technical and unimportant, but it was enough to indicate the beginning of a revolution, and to serve as a prototype of one of the most distinguishing features of all Romanesque and Gothic art, as compared with classic art. It restored the columns to their proper structural function of direct support, so that they ceased to be mere decorative adjuncts in the architectural scheme, and prepared the way for the final abandonment of the entablature in all the Romantic forms of art. It will be remembered that the Romans of the imperial epoch had used the Greek entablature, with all its delicately studied horizontal lines, to adorn a system of arched structure with which it had no proper affiliations. But in forcing this unnatural adjustment of incongruous features they had used such astonishing skill and ingenuity that when classic architecture was restored to the world with the revival of learning, this ingenious incongruity was retained with all the other features of the revival, as an inseparable and consecrated part of classic art.

In this very brief and inadequate outline of the evolution of Roman architecture in classic times, I have dwelt less upon its history and technique than upon a consideration of those qualities in it which have given it an influence so potent over the intelligence of mankind as expressed in buildings. This architecture would have only a curious archæological interest, were it not that it has had such a prodigious effect on the architecture of the last four centuries and a half. It presents itself to the architects of the present day, first, as a precedent of harmonious organic structure, expressed on a heroic scale and with overwhelming magnificence; and, second, as a precedent of an arbitrary system of decorative forms, exceedingly beautiful and interesting in itself, but applied to a structure which it adorns but does not illustrate. We have seen that from the structural elements of this architecture all the main characteristics of the Romantic styles were directly derived, and that from its decorative and entirely conventional elements have been derived that scientific precision of thought and discipline of the mind without which modern civilization cannot be expressed adequately in terms of architecture.

RETOUCHING AND SPOTTING NEGATIVES.

By E. J. WALL, F.R.P.S.

Too frequently it happens that a negative is obtained which, perfect in every other respect, yet has a lot of pinholes in it, or else there are some portions which require blocking in it. This is not difficult for the amateur to undertake, provided he sets about it the right way. The great difficulty is to spot out so that the place which has been retouched may print to the same color and depth as the surrounding parts. There are two distinct methods of spotting out—the first with an ordinary retouching pencil and the second with a pencil. Of the two, the latter is decidedly the easier for an amateur; still, as some may like to try their hand at the former, brief directions are given.

A retouching desk, or support for the negative, is the first desideratum, and, as retouching desks can now be obtained for about 5s., there is no need for a makeshift arrangement. An ordinary printing frame set upon end, and supported on blocks of wood at an angle of about 53 deg., will serve. Behind this should be placed a sheet of opal glass to reflect the light through the negative, and a good sized piece of cardboard fastened to the upper end of the frame will keep off top light, and a piece or two of black cloth glued to this will prevent side light from being a nuisance. The great thing is to allow only the light which passes through the negative to reach the eye.

To use a pencil on a gelatine film, it is necessary to give the film a tooth. This may be done by using a little fine pumice stone or cuttle fish powder on the tip of the finger, but the objection to this is that the scratches —for these substances really scratch the surface of the film—may show. I much prefer to use mattolene or retouching medium, for which I give two formulæ:

I.

Turpentine	1 oz.
Gum dammar	96 grains.

II.

Gum dammar	10 grains.
Guttapercha	1¼ "
Benzole	1 oz.

Allow to dissolve in a warm place, constantly shaking the bottle. The guttapercha for the No. 2 medium must not be the ordinary sulphurized kind, but the pure masticated rubber. Of these, the former has the disadvantage of taking some time to dry, whereas the latter dries very quickly. Whichever is used, the cork should be removed from the bottle, the forefinger placed on the top of the neck and the bottle turned upside down, the finger drawn across the neck, and then rubbed with a slight circular motion over the spot to be touched out till it begins to stick and drag. In a few minutes—about five with the second and thirty with the first formula —the pencil may be used. The grade of pencil must be suited to the negative and the work, but H H is a general all round grade.

If the spot is large, fine wavy lines should be drawn as close as possible across the spot, and then again in the opposite direction, so as to form a very close check work pattern, and if, on printing, it shows at all, lines may be run diagonally.

For small spots the point of the pencil may be held in an almost perpendicular position, and little dots of graphite made very close, but not quite touching. Too much pressure should not be brought to bear on the pencil. Fine, light strokes crossed frequently are better than one thick line.

Although a little outside the subject, I might mention that there is a right and a wrong way of sharpening a pencil for retouching. The wrong way is to sharpen it as you would for ordinary use. The right way is as follows, assuming that one is to use the retouching pencil in cedar like the ordinary pencil:

With a sharp knife begin to cut about an inch and a half from the end; slice the wood off as evenly as possible all round, and, when only a thin section of wood remains near the point, lay the pencil down on a firm support like a table; hold it firmly with the left hand, and the knife in the right, with the edge toward you, and now begin to shave the wood off from the end. As soon as about a half or three-quarters of an inch of lead is laid bare, pocket the knife and lay a piece of coarse emery or sand paper flat on the table, and, holding this with one hand, rub the pencil up and down, turning it round all the time Keep the pencil as flat as possible, the great idea being to obtain as long a point as possible. As soon as the lead begins to gain a point, replace the coarse paper by the finest emery paper or fine ground glass, and work in the same way. A well sharpened pencil should have about one inch of wood tapering down to about half an inch of lead, which should end in a hair-like point.

To spot out with pigment, we want, first of all, neutral gray, carmine, ultramarine, gamboge and Chinese ink, or black, with some strong gum water. Take an old negative glass, and support by the side of the negative, so that you can see through it, and then, with a camel's hair pencil dipped in the gum water, moisten the paints and work up together on the glass till the pigment looks as nearly as possible the same color as the negative film; then dip a very fine pointed brush in the pigment, and, with the point, touch out the pinholes. If large, do not attempt to do this with one spot, but stipple it all over—that is, break it up by minute little dots very close together, allowing those first put on to dry before putting any more on the same place. In this way it is possible not only to block out large pieces of fuzzy trees or obtrusive branches, but spots and pinholes, so that they cannot be seen in the print. The great secret is—match your film colors as closely as possible, use the pigment as stiff or dry as you can and use only the point of the brush.

There is another method which, so far as I know, has never yet been published, and it is, for negatives and prints, the best that I have come across. The idea is not mine, but originated with an enthusiastic amateur. His idea is to scrape the film off old negatives and old chloride prints after they have been well soaked in water, and then to put the film into a little tube, such as is used for some kinds of portable developers—Marion's for instance—to stand these tubes in boiling water, add a drop or two of glacial acetic acid and a little water—very little to the film—and allow it to dissolve. If sufficient acid is used, the gelatine will not readily set again, and one has always ready a mixture of silver and colloid matter with which to touch out any pinholes or spots on prints or negatives; and if two or three developers are used, then one can readily make a paint to match by using an old film; and the same applies to prints. This is applied in the same way as ordinary paint and answers admirably.—The Photographic News.

THE METOL AND AMIDOL DEVELOPER.*

By F. C. BEACH.

WHENEVER any new developer is introduced many old workers in photography familiar with the old standbys, understanding just how to work them to the greatest advantage, are generally skeptical of the claims made for the new developers, and require to see many examples of work, and do, perhaps, considerable experimenting on their own account, before they are ready to admit that there is any improvement.

So it has been ever since the improvement of the pyro developer with sodium sulphite, an ingredient never thought of till 1882, when it was discovered and advocated by Herbert Berkley, and later since the introduction of the coal tar developers, eikonogen, 1889, amidol, metol and glycerine. So it is likely to be in the future.

Amidol struck me at first as being a remarkably simple developer, in that no other accelerator was used than sodium sulphite. It, however, lacked the staying qualities of the next improvement, metol, but it is still useful in many cases. Metol, as many of you know, has the property of dissolving quickly in cold water up to the strength of twenty to twenty-five grains to the ounce; hence when the compound is fresh, or rather has a whitish steel color appearance, a colorless developer may be readily prepared without delay, provided means of measuring a given quantity (such as a mustard spoon) are at hand.

Another essential feature is good sodium sulphite. I have found freshly prepared sodium sulphite solutions work better than those standing for some time. Later experiments, however, lead me to conclude that these solutions can be prevented from deteriorating by contact with the air, if they have added to them a small quantity of sulphurous acid, and it is this point that I desire to bring out. The commercial liquid compounds of metol sold will not retain their colorless character long, especially if the bottle is opened frequently. It is the same when metol, hydroquinone and sulphite are put up in one solution.

The changing of the color indicates that the sodium sulphite is losing its preservative character against oxidization, and of course leads one to conclude that the developing action of the metol must be, in a measure, less powerful.

Taking an ounce liquid measure as a standard, prepare an eight ounce stock solution of sulphite and metol, strength five grains to the ounce of the latter, as follows: dissolve in six ounces of water 160 grains of sodium sulphite, and add thereto half an ounce of sulphurous acid. Next dissolve in two ounces of water forty grains of metol, and combine that with the six ounces of sulphite solution, filter, and pour into a bottle having a small neck. Keep the bottle corked. This forms the stock solution, which is ready for use at any time. The alkali to go with this solution is carbonate of potash or carbonate of soda, as may be preferred. A stock solution of the potash may be made by dissolving in three ounces of water one ounce (480 grains) of carbonate of potash, estimated to contain about twenty grains to one drachm.

To prepare a two ounce solution developer, take one and a half ounces of the metol solution, and add half an ounce of water, and pour this over the exposed plate in the tray. If after two minutes no appearance of an image is observed, especially in what should be the bright high lights, as the sky, then half a drachm of the potash solution should be added, when the image will appear quickly. If a plate has had a rapid shutter exposure, one need not be alarmed at the rapid action of the developer, for it will not fog the shadow in the least; more alkali may be added, in case the details are slow in appearing in the shadows. Generally the larger the amount of alkali added, the greater will be the density of the image in the high lights. It is also noticeable that the metol developer appears to work its way into and through the film quicker than most developers. For the development of lantern slide plates the metol solution may be diluted to two grains to the ounce, and a drop or two of a ten per cent. of bromide of potassium solution added.

A short time ago I learned from Mr. Cornelius Van Brunt his method of developing lantern slides with amidol, which he prefers because there is absolute freedom from fog. His plan consists first in preparing a standard solution of sodium sulphite by dissolving eight ounces in sixteen ounces of water; this he filters and stores in sixteen one ounce bottles filled to the cork. In this way he preserves the sulphite from deterioration. When he wishes to make up a developer he pours a one ounce bottle of the sulphite into a graduate, adds seven ounces of water and dissolves

* Read before the Society of Amateur Photographers of New York, December 10, 1895.

therein ten grains of amidol and one or two grains of bromide of potassium.

As thus prepared he develops in one tray six slides at a time for three successive times. Then he throws the developer away. Having ascertained accurately the right time of exposure, he is able by this means to turn out slides remarkably even in quality, with velvety black tones, and perfectly clear in the high lights. An expert in slide making recently told me that he had adopted the use of the metol and hydroquinone in preference to the latter alone, because of the saving of time in development.

Evidence of the value and usefulness of these new developers is constantly accumulating, the time having arrived when they may be regarded as necessary for the production of the best work.

I need only remark in closing that I hope further experiments by others in the same line will confirm the results which I have ascertained.

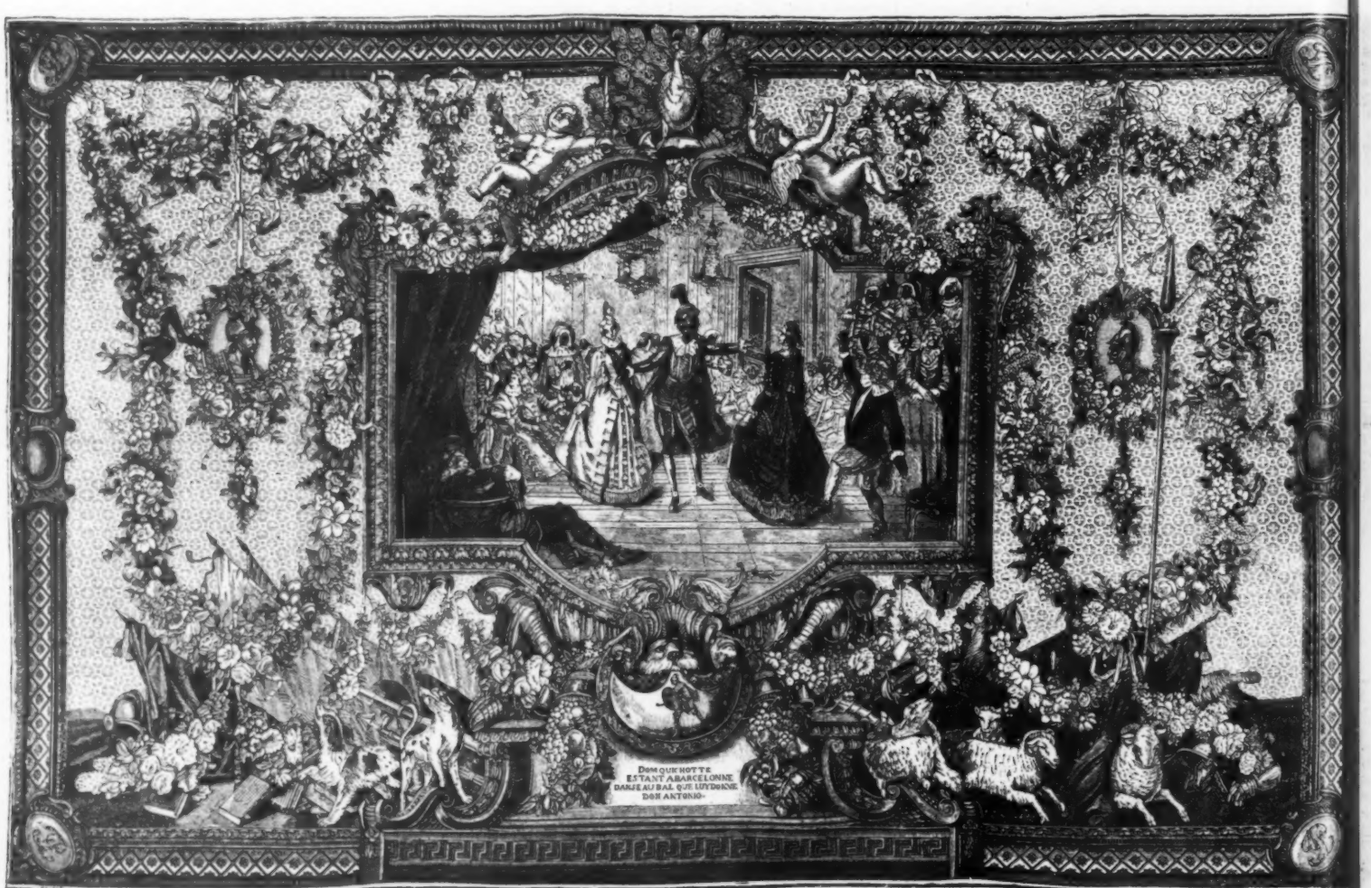
THE GOBELINS TAPESTRY MANUFACTURE.

By ROBERT GRIMSHAW.

FOR many hundreds of years the tapestries of the famous Gobelins establishment have been considered as the acme of perfection for beauty of design, carefulness of workmanship, durability of fabric, and beauty, harmony and permanence of colors. It seems odd to Americans to learn that the establishment was founded in 1450—before Columbus' time—and that it has been in continuous operation ever since, and continuously famous. But such is the case; and about 16 3 (the year with a special card of introduction to Mons. Guignet, I had the advantage of making the personal acquaintance of a most charming and practical man, of being personally conducted by him through parts of the establishment through or even to which the public can not pass

Sitting in the arm chair in which the great Chevreul had sat for so many years, I listened to the account of the gradual growth of the establishment and to an explanation of some recent attacks thereon by the "free" press of the metropolis, which demanded that the time honored establishment should be suppressed, because, among other reasons urged, it was no longer employing the same dyes which had made the establishment famous throughout the earlier centuries of its career. The ground for this charge was that Mons. Guignet had discovered what for the many centuries of the textile arts has been unknown, an absolutely "fast" yellow, so that not only does the establishment employ the formulas for reds and blues and blacks which have proved so lasting, but it has been able to produce yellows which will not become gray or white and greens which will not turn blue The motive of the attacks was even less worthy of respect than the grounds therefor—the writer wished a place in that department of the government which has the Gobelins in charge!

In the laboratory in which the great Chevreul theorized and experimented for threescore years, there are large glass cases filled with all sorts of philosophical and chemical apparatus, some of familiar type, others specially devised for the practical studies which for the most part occupied the great color master. It seems ing the next room, also a laboratory, filled with physical instruments, but in which the most prominent object is a large round white table, bearing an immense sample book in which are fastened hundreds of specimens of wool and silk, dyed of every conceivable color and shade, and dated, with the number of the formula for dye and mordant, and other desirable data, inscribed beside them. This is the daily record of the laboratory work, and is one of many such, this systematic record extending back some years. The cover of this table being removed discloses a wide ring composed of 72 radiating prismatic bobbins (prismatic in form as well as in color), wound with as many colors of wool dyed in the establishment, and constituting the standards from which all shades and tints used in the establishment are made, and to which they are referred. At equal distances apart, around the circle, are the standard red, yellow and blue colors; half way between these come the standard red plus yellow equals orange, yellow plus blue equals green, and blue plus red equals purple. Between the bobbins with the three standard primary colors and those with the three standard secondary colors, come others with graded proportions, so that the red shades off through reddish orange to orange and this through yellowish orange to yellow, and so on around. Each of these twelve colors is used in ten standard shades of intensity produced by varying the proportion of dye in the water or the time during which the yarn remains in the vat. Again, each has ten standard shades or tones produced by various proportions of black added to the standard dyes; so that here we have already over 12,000 standard shades with which to work, as well as the combination



THE ADVENTURES OF DON QUIXOTE—A GOBELINS TAPESTRY OF THE EIGHTEENTH CENTURY, IN THE ROYAL PALACE OF TURIN.

in which Queen Elizabeth died, the time of Shakespeare) it was acquired by the state, which has ever since retained possession of it, and used it as a source of costly—practically priceless—ornamental fabrics, principally tapestries. At present the carpet manufactory of the Savonnerie—only a paltry couple of hundreds of years old—is added to the Gobelins works, so both carpets and tapestry are there produced. Not for the market—because even a Rothschild would hesitate before purchasing carpet or tapestry to produce which costs $800 a square meter, say about $650 a square yard, just for labor and materials.

It was in the laboratory of the Gobelins that the great Chevreul studied and experimented and worked for sixty years, during which time he not only carried on the practical working of the manufacturing establishment, but made and published researches on light colors and dyes, which have made him famous and been of incalculable service to the world at large, and especially to the textile industries of la belle France. But a few years ago the great centenarian died "full of years and honors;" his work and his glorious memory survive him. The present incumbent, his friend and pupil, Monsieur Guignet, relates with grim humor how his first task on assuming charge of the Gobelins was to paint and paper the laboratory where the great colorist had worked longer than most lives, without permitting any change; he who was the great color master of the industrial world having unconsciously permitted his study to become black with the smoke of threescore years.

The general public is admitted to parts of the Gobelins establishment on Wednesdays only; but armed that one of the most prominent objects of research on his part was the influence of one color on another placed beside it: also the effect of various kinds of light (as sun light, gas light, candle light, the arc and incandescent electric lights, etc.) upon standard colors viewed thereby. In this lay the principal part of the artistic branch of his work. The practical part was to discover dyes which should be permanent without destroying the fabrics that were colored therewith, and which in combination should not neutralize or alter each other, instead of producing a previously desired compound color or shade thereof. Either of these alone would be a lifelong task to the average investigator. Chevreul devoted thereto the worktime of over half a century, and after benefiting his country and mankind by his discoveries, died full of years and honor.

In order to enable the visitor properly to appreciate the character of the problems which Chevreul investigated and solved, and the solution of which enables "the Gobelins" of to day to outdo in many respects the best that was done centuries ago in the way of fast colors, Mons. Guignet, in the broad daylight of the laboratory, casts the shadow of his hand upon a sheet of paper on his desk, and asks that the color of the shadow be noted. Then, lighting a candle, he casts a shadow on the same sheet, now by candle light alone, now by the two kinds of light parallel, and now by the two at an angle—and asks the writer what color the shadow cast by the candle appears to be. Many are surprised to find that it is more or less blue according as the candle light or the sunlight is predominant. There is enough in this simple experiment to set artists and those who are not artists a-thinking, before enter- or tertiary colors produced by varying proportions of the three standard primaries. So, when we consider the ten light shades and the ten dark ones of each of these tertiary colors, we need not be surprised to learn that the establishment recognizes over 14,000 different shades in the silk and woolen yarns with which it works (for linen and cotton are excluded). The beauty of the system is that any desired standard shade can be produced or reproduced at will; and any desired shade, as in a painting which is to be reproduced in tapestry, may be copied. Thus, work may be done now which was impossible to the workmen of centuries ago, whose productions have gained worldwide fame.

All dyeing is still done on the old fashioned plan, with mordants; i. e., instead of merely boiling the yarns in a dye liquor which their fibers are supposed to absorb in all permanence, they are first boiled in the mordant, which has the effect, when they are afterward boiled in the dye liquor proper, of precipitating the dye material, or a combination thereof with the mordant, in the pores and on the fibers, there to be practically ineradicable by ordinary mechanical means, such as washing, and unfadable by the action of light, no matter how intense nor how long continued. There is nothing special about the dyeing department, except that care is taken that the dyes are mixed in exact proportions and that the temperature, time of immersion, etc., are invariably, for each color and shade, those which obtained in the test experiments, when the dye was recorded in the great journal of the laboratory and specimens of its results affixed to the record.

I should have added that the last century's experi-

uments have enabled the dyeing of unfadable yellows and greens, which were lacking in the early history of the establishment and, of course, have greatly increased the range of the work possible.

From the dye rooms the visitor is conducted to the carpet weaving department—if the manufacture as here conducted may be termed weaving, for each piece of coloring yarn is tied to the warp or chain, the latter running vertically between the upper and the lower beams or rollers which correspond to the warping beam and the cloth beam respectively in the ordinary loom, in which the fabric is woven in a horizontal position. A piece of yarn of say two inches in length is passed back of a warp thread, and, with a deft movement, securely tied, leaving two projecting ends on the face side. The pattern is outlined of exact size with colored chalk, or its equivalent, on the stretched warp threads, and the model, colored exactly as the carpet is to be, is attached over the workmen's heads (for several men work at once on a carpet, each doing a vertical strip of say a yard or so in width).

The knotted tufts are snugly beaten down as the woof threads or filling threads are, so that the fabric is firm. The necessary knotting threads or tufting threads are chosen and laid out before beginning the work. If there are 150 shades employed in the original design, there must be 150 in the carpet; and if the shading in the original has been done with a brush and blended, there will be needed hundreds and may be needed thousands. Thus we will suppose that there is a green scroll or leaf which presents a round appearance and has considerable area; then each tuft of wool must be one shade lighter or darker than its neighbor, so that there may be no breaks or jumps of color, such as are observable in ordinary worsted embroidery.

The eye of the workman is the only judge as to the selection of yarns to match the colors in the design or pattern; but such is their skill that four or six workmen, side by side at a loom (if loom it may be called), and each producing the same details of a repeated pattern, leave no observable differences and no perceptible breaks between their respective portions.

When the entire surface is tufted, the tufts are shorn to even length, so as to present a smooth, thick, soft pile, which has the merit, aside from the pictorial features, that it cannot be dislodged by wear; and so intimately are the threads and yarns of the fabric interconnected and bound together that even a perforation does not "spread" as in ordinary fabrics.

The same principle is applied, but with different artistic results, in the Turkish carpets which we are now commencing to use so largely. There is a stout back to which the pile is knotted, each pair of tuft threads that appear on the surface being separately knotted to the backing. But, unfortunately, the Turks and other Orientals are learning from us the use of unmordanted and other aniline dyes to supplant the madders, turmerics and indigoes which have already proved themselves capable of enduring the suns and winds of centuries.

In this connection I may say that my family is in possession of the pattern books of the calicoes printed in the latter part of the preceding century by my great-grandfather, Nicholas Grimshaw, who bought the patent right for the process from the inventor, his cousin, Robert Peel, and established the calico printing industry in what was then the kingdom of Ireland. These patterns, when I last saw them only a few years ago, were richer and more beautiful in color than any which I see now; and the dyes were of the simplest—mostly vegetable, with tin and iron salts, and alum as a mordant.

But to leave this lament on the decadence of permanent dye colors and "return to our muttons." The day's work of an operative in the carpet department at the Gobelins seldom exceeds a strip a foot long and an inch wide, and may be very much less.

Next to the carpet making rooms come those devoted to the production of the Gobelins tapestry, the manufacture of which resembles that of the carpets in that there is a backing of stout threads stretched in a vertical plane between horizontal beams, and that to this the pattern threads are separately knotted, but differs from it in that the work is done from the back instead of from the face, and the pile or thread ends project from the back, leaving that side rough, while the face side shows only the firmly drawn bights of the coloring threads. The workman sits behind the warp threads or chain and the design is behind him; a mirror attached to the chain threads in front of him reversing the pattern, so that by making it left handed at the back of the chain, it appears right handed or unreversed on the face. The rate of progress is much slower, by reason of the yarns being finer and the designs more complicated and containing more shades, so that six square inches per day is a good average day's work. It may be said that a square meter (an area 39·4 inches on a side) per year is the average production per man, the cost being about $800 for this area.

None of the carpets and none of the tapestry produced by the Gobelins establishment are ever offered for sale by the state. They are used in the palaces and great public buildings and given to friendly potentates or to others who have rendered (or are expected to render) important services to the government of France; so that when we read, as we often do, in novels and the like, of luxurious private houses hung with Gobelins tapestry, we may know that the author was not "posted." Gobelins tapestries never get upon the market unless a king or an ambassador or some other recipient of the French government's bounty "goes broke," and then it takes a Rothschild or a prince to buy them.

The two examples of Gobelins tapestry which we present are from the Tapisseries, Broderies and Dentelles of M. Eugène Muntz.

A CONQUEROR—GOBELINS TAPESTRY OF THE NINETEENTH CENTURY, IN THE MUSEUM OF THE GOBELINS, PARIS.

PENETRATION OF THE LEE-METFORD RIFLE.

DURING experiments at the Royal Military College to test the penetrating power of the Lee-Metford rifle, the bullets fired at a wicker gabion filled with wet sand went clean through and were lost. The next target was a solid wall of sandbags. Here the bullet penetrated 28 inches and 30 inches. In the 30 inch penetration the bullet went straight for 20 inches, then turned at right angles for 8 inches, and afterward, again at right angles, in the direction of the firing point, where it was found undeformed. A target of loose sand was then tried. On the first day the bullet passed through 3 feet, and was then lost. On the second the target was deepened by a foot, and on this occasion also the bullet passed through and was not afterward seen, thus giving an inconclusive result. A mound of loose shingle of 1¼ inches gage proved a most formidable objective. On the first day a 4 inch special bullet was used, and this was found broken into shavings. On the second a 6 inch bullet was used and broken up fine by the impact. A severe test was one against a matchboard wall, the sides of which were 3 inches apart and filled with shingle varying from ½ inch to 1½ inches gage. In the first experiment the bullet just got through, and in the second it went right through. In a similar experiment to the last, but with the sides of the wall 4½ inches apart, on the first trial the bullet failed to penetrate, but on the second occasion it lodged in the back board, just starting it. The next experiment was against a matchboard wall with sides apart as in the last, but filled entirely with shingle of ½ inch gage, and on both days the bullet passed through. In a subsequent trial with a 6 inch matchboard wall, filled with shingle of ¼ gage, on the first day the bullet failed to get through, but on the second it lodged in the backboard. Against a matchboard wall, the sides of which were 4½ inches apart, and filled with shingle of 1½ inches gage, on the first occasion the bullet just failed to get through, but on the second the penetration was complete. With walls 6 inches apart and shingle of similar gage to the last, the bullet failed to go through on both occasions, but on the last it penetrated 5 inches. Shooting at fir tree logs on one day 27 inches thick, and on the next 37 inches, the bullet passed through and was lost in both instances. Oaken logs proved less vulnerable. In the first experiment the bullet passed through 16 inches and was lost. In the second, however, the target consisted of two trees, each 12 inches in diameter, placed one behind the other. The bullet penetrated 20 inches, going straight through the center of the first and on entering the second turned sharply to the right at about an angle of 120°, traversing another 8 inches of oak, where it was found undeformed. Firing against a stockade of 56 pound steel rails on both days it was found that the section of rail against which the bullet impinged was dented. One target was composed of soft brick, and against a 14 inch wall stretcher brick the bullet penetrated 3¼ inches; against a wall of similar thickness header brick the penetration was 5 inches; against a 9 inch wall stretcher brick the penetration was 4 inches, and against a wall of the same thickness header brick it was 5 inches. Against hard brick laid as the soft kind were, the penetration was, in the case of the thicker walls 3 inches and 2¾ inches respectively, and in that of the thinner walls the penetration was exactly as against the former. Fired against a ½ inch steel plate the bullet on both days punched a clean hole. In the experiments against the brick walls the range was 12 yards, in the remainder it was 20 yards.—Army and Navy Journal.

ELECTRONITE.

A NEW explosive, called electronite, is being introduced by a London firm for use in fiery and dusty mines. It has been tested at the experimental station at Messrs. Pearson & Knowles' colliery, Moss, near Wigan, with most satisfactory results. Five charges of 8 ounces each were fired without flame and without giving rise to explosion or to charring of coal dust, as shown by the following report:

EXTRACT FROM OFFICIAL REPORT.

1. Coal dust.....	8 oz.	Electronite.	No flame nor explosion, dust not charred.
2. "	8 "	"	"
3. Coal gas, 5 per cent. and coal dust .	8 "	"	"
4. Coal gas, 10 per cent. and coal dust .	8 "	"	"
5. Coal dust.....	12 "	"	"

Also a charge of 8 ounces electronite, the bore being filled up with coal dust from Plas Power colliery; result—no flame, no explosion. A 6 ounce charge immersed in coal dust in the open failed to ignite it. And a charge of ½ ounce electronite 2 projected a 35 pound ball from a mortar a distance of 147½ yards. All the above shots were fired without any stemming, with the exception of No. 1, which was covered with 4 inches of loose dry sand.—Engineer's Gazette.

ZINC PRODUCTION.—The production of spelter has increased from 74,004 short tons in 1894 to 85,491 tons in 1895, though the average price of spelter for the year advanced but little, being in New York 3·63 cents per pound as compared with 3·52 cents in the previous year. The zinc oxide production remained stationary at 22,814 short tons in 1894 and about 22,690 tons in 1895. There was produced in addition to this a certain amount of zinc-lead pigment.—The Engineering and Mining Journal.

[Continued from SUPPLEMENT, No. 1049, page 16766.]

THE ARC LIGHT.*

By Professor SILVANUS P. THOMPSON, D.Sc., F.R.S.

LECTURE II.—Continued.

INFLUENCE OF CRATER IN EFFICIENCY OF LIGHTING.

MR. TROTTER'S admirable paper deals, among many other things, with one very interesting practical point. Some years ago it was proposed by Sir James Douglass—a name so well known in connection with lighthouse work—to employ, for lighthouse illumination and projector lamps, a form of carbon rod, different from that which had been previously used. If I am rightly informed, the old carbons originally used in the lighthouses in Dungeness and elsewhere were made from battery carbon or retort carbon, sawn into square sticks about a quarter of an inch each way. They were afterward replaced by round rods of somewhat larger diameter, and, for very powerful lights, by still larger rods. Sir James Douglass seems to have thought he would obtain a better light, a more central, steady, luminous patch to project through his lenses if he could avoid the wandering of the arc over the large surface of the crater. The wandering of the arc, when the carbons are too thick in proportion to the current used, is one of the things familiar to all who work with arc lamps. If you employ a larger size of carbon rod than is necessary for the size of the crater, that is, proportionally to the current, the crater will not be fully filled with light, but a luminous spot of the light will wander round and round unsteadily in the crater. Then at irregular intervals the crater wall will give way, sometimes on one side, and sometimes on the other, and you have loud hissing and extreme unsteadiness. It occurred to Sir James Douglass that if he fluted his carbons he would obviate the formation of a crater rim; he would, instead, obtain a crater with an edge consisting of points at regular intervals with spaces between, and presumably a more steady arc. Mr. Meyer has sent me these two specimens of Sir James Douglass' lighthouse carbons. They look to me as if they were taken from an alternating current lamp. Neither of them has a well-formed crater. There is here a second pair of fluted carbons, intended for a smaller lamp, which have the same peculiarity. Mr. Trotter examined the arcs made by using fluted carbons, and reading between the lines, I judge that he was not favorably impressed with the arc produced under those conditions. The fact is, if you want a good light, you must have a good crater. This I take to be the explanation of the attempt to improve carbons by coring them; that is, by making them tubular, and filling the bore with carbon of a softer quality. This device appears to have a beneficial effect in anchoring the arc, and preventing it from wandering round the crater, by giving it a kind of foothold. The soft core tends, in fact, to promote the formation of a crater, and, consequently, to steady the arc. With very short arcs, and arcs that hiss, the crater is generally very irregularly formed and much deeper as a cup than is the case in the long arcs. The mushroom growth that is observed with hissing or short arcs is formed at the expense, in fact, of material torn up from the bottom of the crater. This is but one of a number of irregular phenomena which really need not engage us further, but must, however, be taken into account in any complete account of the optics of the arc. The rapid changes of color in the flame, whenever the arc is in an unstable state, are very curious.

WHITENESS OF THE ARC LIGHT.

Another very important point in the optics of the arc is its constant degree of whiteness. It was found by Captain Abney long ago, in 1878 or 1879 I think, that the relative amounts of the radiation of different colors—red, blue, yellow, and so forth—in the arc light are always the same, other things being equal; the arc is, in fact, of a constant degree of whiteness, so much so that for years he has used it as a standard of comparison in his researches on color photometry. This constant degree of whiteness, so far as it is true, is evidence of constant temperature, or possibly of constant temperature coupled with constant emissivity. It is a curious point that when the arc wanders from spot to spot, in the rapid fluctuations that sometimes occur—about which I shall have something to say presently—the apparent whiteness of the arc remains the same, although the intensity of it may vary, that is to say, one patch may look whiter than another patch by having more light coming from it, yet you do not get a change of color. You cannot say that it is any redder, any greener, or any bluer, there is simply more light coming from it; so that it appears that there may be something comparable to constant temperature, and yet different emissivities at portions of the same surface.

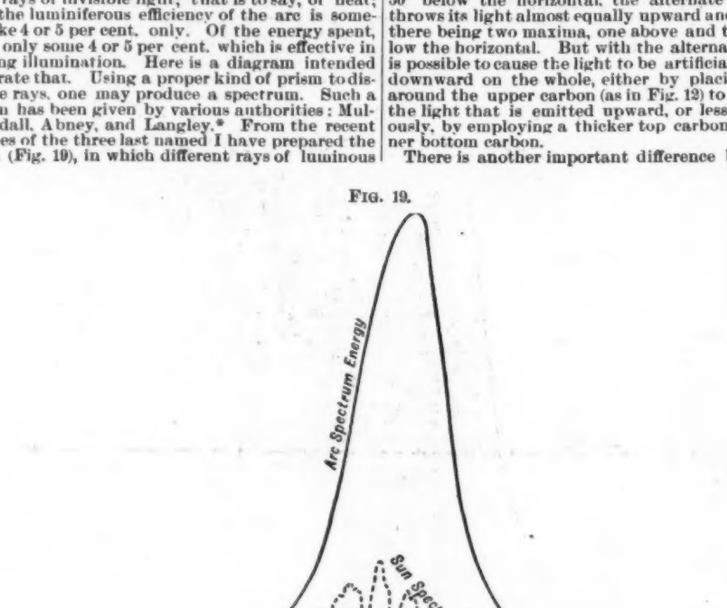
So three years ago Mr. Swinburne and I, independently, suggested that, seeing the arc is always (or was supposed to be always) of a constant degree of whiteness, the very best standard of white light would be that of a fixed area or patch selected from the crater of the arc (by means of a diaphragm having a very small hole in it). We could desire no more perfect standard of white light than one always equally white and of a fixed size. This suggestion of using a square millimeter, let us say, of incandescent carbon at arc temperature, as the standard of white light, was a very fascinating one. I did my best to have it taken up in Germany by the late Professor Von Helmholtz. The last letter I ever had from him was on this subject. The suggestion has been put to trial both by Mr. Trotter, in London, and by Mr. Blondel, in Paris. The result of it all is that, fascinating as the idea may be, it will not do; not only are there inherent difficulties at the very high temperature that prevails in getting the light through the small diaphragm placed close up to the arc, but as Mr. Trotter has found, the variations of the light are so extraordinary that at present it seems unlikely that we shall ever in this way attain a true standard of invariable amount.

What, then, are these variations about which I am speaking? In the first place, if the carbon contains impurities, the light is of lower intrinsic brightness. The soft variety of carbon used as a core in the cored carbons shows as a duller patch at that part of the crater. As an experiment I had an arc light carbon cut down lengthways; there was fixed up against it a pencil made from the best graphite one could get, a pure natural graphite. This combination was, in fact, a carbon rod, half of which was ordinary arc light carbon and half of which was plumbago. Using this compound rod as a top carbon, I found the crater to be unequally illuminated over the two halves. The supposed pure graphite shone less brightly; it was white; but it shone with a different amount of light from the patch of ordinary arc light carbon, just as the cores of the cored carbon pencils shone with a different degree of brightness. In using cored carbons you in fact sacrifice a little of the candle power in order to obtain steadiness. It is a not unimportant fact that impurities lower either the temperature or the emissivity of the surface, and the result is a want of standard condition. The more recent discovery of Mr. Trotter—presently to be described—is much more upsetting.

LUMINOUS AND NON-LUMINOUS ENERGY.

The energy that is given out by surface light is, unfortunately, not given out only as light. There is other energy of a non-luminous kind. I am not exaggerating when I say that only about one twentieth or one twenty-fifth of the energy supplied to the arc, and emitted at the crater, is effective in producing illumination. To put it in a popular way, for every ray of visible light you have given out, you have 24 or 25 rays of invisible light; that is to say, of heat; so that the luminiferous efficiency of the arc is something like 4 or 5 per cent. only. Of the energy spent, there is only some 4 or 5 per cent. which is effective in producing illumination. Here is a diagram intended to illustrate that. Using a proper kind of prism to disperse the rays, one may produce a spectrum. Such a spectrum has been given by various authorities: Muller, Tyndall, Abney, and Langley.* From the recent researches of the three last named I have prepared the diagram (Fig. 19), in which different rays of luminous and non-luminous light are supposed to be plotted out before you. In this case the luminous spectrum occupies a very small part of the diagram. The smallest of the three curves is Captain Abney's curve of relative luminosity or sensitiveness of the normal eye to different kinds of light. The eye is most sensitive to light in the yellowish or greenish yellow, and least sensitive to the red, and to blue and violet. What proportion do these radiations to which the eye is sensitive, and which are effective, therefore, for the purpose of illumination, bear to the whole amount of radiation? Only this very small area underneath that curve of luminous energy as compared with the area underneath the tall black curve, which represents the spectrum of the total emission of visible and invisible rays from the arc. Right away down in the infra red you have this enormous development of waves of slow period—heat waves in fact. They are given out in far greater abundance than the waves which affect the eye as luminous waves. The ragged curve which is intermediate between the others represents, to the same scale as the arc spectrum, a spectrum for an equal amount of light, if derived from the sun. It shows how waves of a certain length are absorbed off by the intermediate atmosphere between us and the sun. This curve is taken from Langley. One of the things we have to look forward to in the development of artificial light is the production of lamps which shall be of a higher efficiency than the arc lamp. They must, for an equal amount of energy supplied to them, emit a far greater percentage of waves of a length that will affect the eye as luminous waves, and a far less percentage of those longer waves which do not help the illumination, but which only warm us. Such a transformation has been wrought for gas lighting in recent years in the introduction of Dr. Auer's incandescent mantle. He discovered a material whose emissivity, at the temperature of the gas flame, is higher than that of the carbonaceous matters in the ordinary flame of coal gas; it emits a greater percentage of waves of the sorts that affect the eye and a lesser percentage of the non-luminous waves. The vacuum tube lamps, and their modern varieties, such as Tesla's lamps and Ebert's luminescence lamp, are attempts to procure a better specific luminescence from a given amount of energy.

FIG. 19.



ALTERNATE CURRENT LIGHTING.

I have on the table here the means of producing an alternating current arc. The alternating current may be turned on and then the arc struck by hand between the two carbons. By means of a choking coil I am able to regulate the amount of light given out by the current passing through the arc, and with this lens I will project the arc on the screen, so that you may see the difference between the normal arc, as made with a continuous current, and the alternating current arc. You will find that, in the latter case, the tips of the two carbons are heated almost equally to whiteness, and assume almost identical shapes.

If the carbons are of the same quality, the beating and the consumption of them would be precisely alike, except for the slight difference due to the circumstance that the ascending hot gases around the arc make the upper carbon hotter. The two luminous areas on the two tips are of equal area and equal whiteness, and, as projected on the screen, appear as two luminous patches of equal size; but in neither the upper nor the lower carbon is there either a well developed crater or a well developed peak. The fact is that each tip has to serve alternately as crater and as peak, so that the resulting form is a compromise. We are able then at once to recognize whether the arc is being supplied by a current that is continuous or by one that is alternating.

The distribution of light in the space surrounding the arc corresponds to this difference in the distribution of the luminous surfaces. Whereas the continuous current arc throws its light (when the crater is at the top) mainly downward, with a maximum at 40° to 50° below the horizontal, the alternate current arc throws its light almost equally upward and downward, there being two maxima, one above and the other below the horizontal. But with the alternate current it is possible to cause the light to be artificially projected downward on the whole, either by placing a mirror around the upper carbon (as in Fig. 12) to reflect down the light that is emitted upward, or less advantageously, by employing a thicker top carbon and a thinner bottom carbon.

There is another important difference between the light of the alternate current arc and that of the continuous current arc which affords a ready means of discriminating between them. The alternate current arc is subject to a regular periodic fluctuation. The rapidly reversing current pulsates and the arc pulsates too. The current actually stops and then starts again in a reversed direction some hundred or more times in a second. The flame does not actually go out, but it dies down, and before it has had time to go out the current has started again in the opposite direction. If the flame did not thus persist, it would be impossible to operate arc lamps at all by means of alternate currents. I can show you, by a simple experiment, this fact of persistence.

I take here a continuous current arc, and clamp the carbons immovably at the normal distance apart while the arc is burning steadily. Now, by means of a reversing switch, worked by hand, I suddenly reverse the current. The light blinks at the instant of reversal, but does not go out. An interruption of say one-hundredth of a second does not put out the light; the flame had not time to die away. It is not accurately known what the maximum duration of an interruption may be, but it is known that arc lamps cannot be practically operated with alternating currents, if the frequency is less than about 40 periods per second; that is to say, if there are fewer than about 80 reversals per second. That the light of an alternate current arc does thus fluctuate can be made evident in the simplest possible way. If one whirls a white rod, or waves it rapidly up and down, in the light of the arc, one perceives a succession of images. When a rod is made to throw its shadow on the screen, and is then rapidly waved to and fro, the shadow is observed to be broken up into a series of maxima.

A silver coin tossed into the air shows a succession of images as it falls. By merely shaking my hand in the light of the alternating arc, I appear to possess an enormous number of fingers. The current here used is derived from the generating station at Deptford, where Mr. Ferranti's machines work with a frequency of 85 periods per second. Consequently, we have 170 successive images per second for any quick moving body. I have frequently found out whether arc lamps were worked with alternating currents or by continuous currents, by standing under a lamp post at night, and twirling my walking stick. You

* Lecture delivered before the Society of Arts, London, 1895.—From the Journal of the Society.

* Langley, "Researches on Solar Heat" (Washington, 1884), plate xi.

can tell an arc lamp that is alternating by another circumstance, viz., that in addition to any fizzing or hissing that there may be, you hear a kind of continuous hum. In the lamp now before you, you may hear the hum of the machines at Deptford. If I increase the current, you will hear it still more loudly. The loudness of the hum also depends on the form of the individual waves of current.

EFFICIENCY OF ALTERNATE CURRENT ARCS.

There has been some discussion of late on the question whether the alternating current arc was as efficient as the continuous current arc, that is to say, whether for a given consumption of energy you obtain an equal proportion of light. Prof. Fleming has made measurements, and written learnedly on the subject. I do not dispute the accuracy of his observations, or that of others who had made observations on the subject. I wish to give you an absolutely A priori view. This is a matter I have not measured myself; therefore I am absolutely unprejudiced, but it seems to me perfectly absurd to suppose that, if you take the right mechanism, select the right size and quality of carbon, and use it properly by the light of experience, applying the appropriate amount of current, there will be any difference whatever in the efficiency of the alternating current arc and that of the continuous current arc. I do not see where there is room for any difference. At one time it was supposed that incandescent lamps were not as efficient if worked with alternating currents as with continuous currents. That heresy was long ago exploded by Profs Ayrton and Perry when they showed that it was merely a question of getting the right voltage appropriate to the measurement of the lamp. I am bound to say I think the same kind of considerations apply here also. Since the heating effect of a current is proportional to the square of the current strength, what difference does it make, what difference can it make, whether the current is going in one direction or in another? If you spend the right amount of energy on the right amount of carbon, by raising it to the right amount of temperature, you are bound, other things being equal, to have equal results. If you arrange your things badly, so that some of the energy is not spent, as it ought to be, on heating the carbon white hot, I grant you may get a different result; but it seems to me, from a priori reasoning, to be absurd that you should not have equal efficiency with the alternating current as with the continuous current.

SPECTRUM OF THE ARC.

My next experiment is to project upon the screen the spectrum of the arc. Arrangements are made in the following way: First of all, the arc is produced inside a lantern; it is then focused by a lens upon a small auxiliary screen three feet away from the arc. This screen has a narrow slit down it, the image of the arc being formed on a slit. Through the slit then there passes a vertical slice out of the arc. In this slice we shall have a bit of the top carbon, a bit of the arc in between, and a little bit of the bottom carbon—one above the other. The light of this luminous slice is then passed through a prism, and on through a focusing lens, producing on the screen a spectrum of that portion of the arc complete, from the red end on the right to the violet end on the left. Now notice what that spectrum consists of. The upper luminous streak is the white light from the crater spread out into its various component colors in their proper order one after the other. The light of the bottom strip, which also goes from red to violet, is the light from the peak of the negative carbon. The apparently dark patch in between them shows you the spectrum of the pale flame or arc. Only those who are near can see it properly, but in this comparatively dark tract between the upper and lower carbons the spectrum shows a number of nebulous bands, two in the green, a brighter one in the bluish green, and another one about the end of the blue or beginning of the violet. Those bands are the well known spectra of the element carbon, so that we have here the optical proof that the flame between the two carbons consists of carbon vapor in an incandescent state.

THE INCLOSED ARC.

More properly belonging to the subjects comprised in my first lecture is the matter next to be mentioned, of the peculiar effect produced on an arc by burning it in an inclosure which prevents access of fresh air. The properties of the inclosed arc have been investigated by Mr. Marks, to whom is due the disposition which I here exhibit. It may be fitted to any ordinary form of arc lamp. The lower carbon projects through and supports a metal disk with a raised rim, on which stands a small glass jar about three inches in diameter. The upper carbon comes down into this through a rude stuffing box at the top of the jar. The arc is formed in the usual way, only it happens to be inclosed, so that the air cannot come in from below or readily pass through the rough stuffing box at the top. The air in the jar is in a few minutes deprived, by combustion, of its free oxygen; so that, from that time onward, the arc is burning in an atmosphere that will not support combustion. As a consequence, the actual waste of carbon is much smaller than is usually the case. In some experiments on the ordinary arc, made by Mr. Preece, with a Brockie-Pell lamp, using about 6½ amperes at 50 volts, with a 13 mm. carbon for positive and an 11 mm. carbon as negative, the mean consumption per hour per ampere was found to be, for the positive carbon, 3·52 mm. (length), or 0·504 gramme, and for the negative carbon 2·86 mm., or 0·176 gramme. (Dr. Strecker gives, as the experience in Germany, 0·75 and 0·375 gramme respectively.) Now, this consumption of carbon may, as Mr. Marks has shown, be greatly reduced by simply preventing access of fresh air.

This actual lamp has been tried. My friend, Prof. Walmsley, of Edinburgh, has been good enough to communicate to me the figures obtained during a run of 14 consecutive hours. The carbons were those ordinarily used in Brockie-Pell lamps, but the actual lamp used was of Brush-Sellon pattern. The current was 10 amperes, and the mechanism was adjusted to give a rather long arc. Of the positive rod, the length consumed per pair when burning open was 47 millimeters; when inclosed, only 2·84 millimeters. Of the negative carbon, the length consumed per hour when open was 18·7 millimeters; when inclosed, only 0·62 millimeter. The positive carbon, when burnt in this way, only burns at about one-tenth of the rate at which it burns away in air, while the negative carbon only burnt away at about one-thirtieth of the rate at which it burns in free air. The total consumption, when inclosed, is, therefore, about one-twentieth part of what it would be for the same current when the arc was burning in open air. There is, however, one drawback to the use of an inclosing vessel like this; viz., that the interior of the vessel gradually becomes coated with a brown dust which obscures the light. On that Prof. Walmsley made some observations, and came to the conclusion that after 18 hours the light was approximately about half of what it would have been without the globe. As a matter of fact, it is a brown deposit, which cuts off rather more of the green waves than it does of the red waves.

THE TROTTER PHENOMENON.

I now come to the most recent and by far the most important of recently discovered arc phenomena. Mr. A. P. Trotter has observed a phenomenon in the arc which has so completely changed one's ideas as to the nature of the crater surface that one needs to reconsider everything previously learned or observed.

When you project upon the screen by means of a good achromatic lens (such as a camera lens) an image of the arc and adjust it so as to get a good view of the crater, a little care will enable you to discern, as often as not, somewhere in the middle of the luminous crater—not always exactly in the center—a nebulous patch, sometimes extending in different directions. This patch is more luminous than the surrounding surface of the crater, over which it moves in a capricious way.

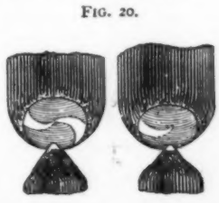
Sometimes you can catch a glimpse of this patch revolving, flickering round and round; sometimes it goes round one way and sometimes the other. You cannot readily observe it, however, unless you resort to artificial means, because of the rapidity of its motion. So to see it, you must have recourse to the stroboscopic method. Take a simple disk of cardboard 8 or 10 inches across. Cut in this a number of equidistant narrow radial slits—say 36, 48 or 60—and blacken the disk to obviate stray reflections. Put a pin through the center, and fix the pin into a wooden handle. Spin the disk by hand and watch the arc through the slits. You will then, at moments when the frequency at which the disks pass the eye corresponds to the rapidity at which the movements in the arc occur, catch sight of the moving object. A second method, suitable for projection of the phenomenon on the screen, is to mount a similar disk upon a small electrically driven motor right in front of the arc. A suitable frequency is 400 per second or so. A third method of observation consists in throwing the image of the arc not upon a stationary screen, but upon a revolving disk painted half black, half white.

By the use of each of these methods Mr. Trotter succeeded last summer in proving that in the arc there is a phenomenon of rotation of something, the precise nature of which is not yet known. The discovery was communicated in due course to the Royal Society.* The essence of the stroboscopic method is that it gives a stationary or slowly moving view of a rapidly moving object. If a thing is revolving so fast that the eye cannot follow it, it may be readily seen, if the observer is furnished with an apparatus which will allow the eye only to catch a momentary glimpse once in each revolution. Suppose that just at the instant when one slit passes the eye the revolving thing is in a certain position, and that by the time the next slit has come opposite the eye, the revolving thing has gone exactly once round, the eye will see it as though it had not moved. If the frequency with which the slits pass the eye does not precisely correspond, the revolving object will seem to revolve slowly, either forward or else backward, according as the frequency is either too small or too great.

The thing that Mr. Trotter has found in the arc is a white object, having a sickle shape or comma shape, extending from some place near the middle of the crater to its edge and revolving in a singularly capricious manner. The wandering whitish spot that is seen without the use of any revolving disks is apparently the head of the comma shaped object, the tail of which moves usually so fast that its form cannot be seen, except by the use of the revolving slits.

By the kind co-operation of Mr. Trotter I am able to show you this rotary phenomenon. An arc lamp arranged to be hand-fed is inclosed in a box. In front of the lamp is a small lens to throw an image on the screen, and immediately in front of the lens is a rotating disk of tinned iron provided with slits, mounted upon the shaft of a small but rapidly revolving electric motor. The slit disk, as it revolves, cuts off the light and restores it intermittently. We can vary the intermittences from 200 to 400 per second by changing the speed of the motor. What we have to do is to project a well-formed image of the crater upon the screen and watch it while the rotating disk gets up speed, until the right speed is attained. We then see a sickle-shaped white patch (Fig. 20), which appears

FIG. 20.



to rotate slowly backward or forward about a point as center, or to stand still, according as the rotating slits go too quickly or too slowly, or keep in perfect synchronism with it. It usually has its center in the middle of the crater surface and extends to the edge. It is at the present moment in very rapid rotation; now it apparently decreases its speed and stops for a moment, so that its shape is clearly visible. It appears as though the luminous part of the crater were shaped like the blade of a chaff cutter, and whirled round with great rapidity. Now it changes its direction and goes too quickly to be visible. Sometimes, when the speed of rotation of the object on the crater surface is only half as great as the speed of the disk, you get two views of the sickle-shaped object at opposite sides, forming a double figure (Fig. 20); and sometimes one gets a treble appearance, or even four sickles, meeting like a star in the center. Supposing you have the rotation well developed and then alter the current gradually, the speed changes in a perfectly regular way; and yet, supposing there is a given current and the thing is going round at one particular speed, all of a sudden, without any warning whatever, the direction of the rotation may reverse and yet keep the same rotary speed. When it reverses its direction of rotation it reverses its form also; the concave edge being always the advancing one. That is one of the most puzzling things in the whole phenomenon. Apparently with each current there is a particular speed of rotation that corresponds. The rotation is not a mere optical phenomenon of the surface of the crater, for, taking a lateral view of the arc and examining the flame part between the crater and the peak, Mr. Trotter has found evidence that the flame is itself, from top to bottom, also in a state of rapid rotation corresponding to what one sees in this white sickle-shaped body going round on the crater surface.

Interesting and puzzling as the Trotter phenomenon is, I fear it puts an end to the hope that the crater of an arc lamp might be used as a standard of light.

RECENT OBSERVATIONS BY MR. CROMPTON.

Mr. R. E. Crompton has lately noticed another arc phenomenon which was previously unknown, unless, indeed, it has been casually observed without the reason for it being known. It is the following: An arc may be burning perfectly steadily—of the proper length—everything going on without the smallest hint of any discontinuity, and all of a sudden, for apparently no reason whatever, the arc will enlarge itself, flaming out sideways, and the flame will go up round the upper carbon, and lick round it once or twice, and then everything will resume its former condition. Mr. Crompton observed this under the following circumstances. In order to study the feed mechanism of different lamps, and to find out which was doing its duty best, and also to study the properties of carbons with a lamp of any particular mechanism, he took records with a recording voltmeter of the difference of potentials between the carbons of the arc, and obtained a very large number of curves. If a recording voltmeter is put across the terminals of a lamp, and the feeding mechanism sticks, you have a record of the fact by a slight kick in the curve. If the feeding mechanism stops, and the feed does not take place when it ought to do, the arc will lengthen unduly, and the voltage across will rise, and that rise will go on for some time until the feeding mechanism does choose to work. As a general rule, a feeding mechanism which waits too long feeds too much. It overfeeds, because it has waited too long, and down comes the voltage suddenly, causing a deal of irregularity before the steady condition of things is resumed. All this will be duly recorded in the irregularities of form of the curve drawn by the instrument. With a more perfect arrangement of feeding mechanism, you will have comparatively small changes in the voltage.

Records of this sort enable an engineer to pick out that particular mechanism, or to find the particular adjustment of mechanism which will give the most equable voltage on the lamp, and, therefore, obviously will cause the lamps to burn with the least flickering. Thanks to Mr. Crompton's kindness, I have here a number of these records. In this case the records are taken, not from a variety of lamps with different feeds (good and bad), but from a single lamp with a good feed. The object of this particular set of records was to study the different qualities of carbon in the same lamp. The first record shows a very even line; there are very slight undulations upon it; the feed was doing its duty; the carbon has got burnt down to a short stem, and the rod had descended, as far as the stop would allow it to; the arc became too long; the flame burnt itself out; the potentials rose until the arc broke, and the record stops in the middle of an upstroke.

The next record shows the same quality of carbon in use, but with two strange differences from the previous one. There are a number of small details, which indicate that the feed was taking place at more or less regular intervals. It is a very fair curve, with a number of little nicks in it, which show that the feed had taken place rather more markedly than usual; but at two places in this record there is a great disturbance. In the middle of the comparatively quiescent line there is a sudden irregularity, which then settles down. Now a great disturbance like that may be due to the following circumstances: The particular kind of carbon used was one which had certain impurities in it. All carbons have impurities, but this appears to have had impurities of a particular kind, whether silica, lime, iron, or what, I do not know. When the carbons were examined the following peculiarity appeared. Behind the crater, right up at the wide part of the conical surface, there accumulated, as there usually does accumulate upon the carbons of arc lamps, a brownish dust. In the present case, as soon as a sufficient quantity of dust had accumulated upon the base of the cone, the arc suddenly spread upward, and, like a good housemaid, swept off the dust with a tongue of flame, and then subsided; waited until a further aggregation of dust had accumulated, and then went housemaiding again. Among these records, several of which show this same phenomenon, there are some curious things, one of which illustrates the suitability or otherwise of a particular kind of arc lamp for use in a particular kind of building. In one case, where there are a number of cases of slight overfeeding, the record suddenly becomes very quiet indeed, the curve from that moment onward becoming almost a uniformly straight line. The record is marked as follows: "A to B tea time, nobody walking about overhead." The lamp was suspended by a cord over a pulley, and the vibration of the building had caused the feeding to be a little irregular at times; but when there was no vibration the feed was more regular. It is not with

* Proc. Roy. Soc., June 21, 1894, lvi, 262.

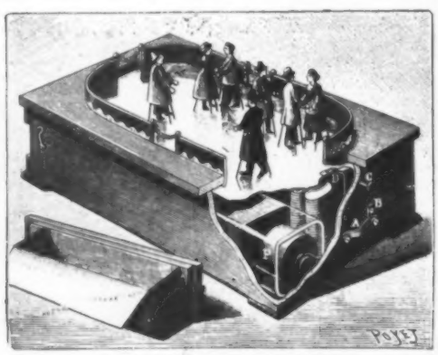
all lamps that this occurs. Some lamps burn better in a building where there is little vibration to joggle the feed and prevent it waiting too long. Again, if a lamp is set to work at a certain voltage, and then you use it at a voltage that is wrong, you get irregularity. Here, for instance, is a lamp of which the record at 40 volts is a most beautiful straight line, there is hardly the slightest irregularity, but the same lamp worked at 52 volts across the terminals is highly irregular. There is a regularly recurrent irregularity in the action of the feed at this higher voltage.

Again another fact Mr. Crompton has observed by following out these records, viz., that if carbons are left in a damp place where moisture can be slowly and regularly imbibed into the pencils, such a carbon, even although of good quality, may give rise to great irregularities. Here is a very irregular record, for instance, obtained from an extremely good carbon, one of Hardtmuth's make. That same carbon taken out and dried in a stove above steam temperature for two days gives a record which has not a flaw in it. Apparently the warmth of the hot air ascending up from an arc is not sufficient to drive out from a carbon the moisture which has been slowly accumulating in it. It seems to be very necessary, if you would have an arc burn with great regularity, to keep your store of carbons in a dry place.

But this topic does not strictly belong to the optics of the arc; it relates rather to the question of the mechanism of lamps, which is the subject for my next lecture.

THE ELECTRIC DANCING PUPPETS.

UPON a piece of sheet iron forming the cover of a wooden box are placed small figures held erect by means of four supports made of horse hair. As soon as the handle, A, is placed upon the contact, B, there occurs a strong vibration of the plate, the figures move about



THE ELECTRO-DANCERS.

in all directions, seem to engage in conversation, turn around and leave each other only to find themselves together again an instant afterward. From their costume merely it might be thought that they were at an evening party, and from the often regular motions that they execute, that the party was a dancing one. A music box concealed in the apparatus adds to the illusion, and consoles children for remaining alone at home while their parents are amusing themselves at a distance.

The mystery is simple. The battery, P, furnishes a current that passes through the plate and the point, D, whose position for exciting the electric apparatus and giving the vibration the amplitude that the child prefers for his puppets is determined by the screw, C.—La Nature.

THE ELECTROLYTIC ACTION OF RETURN CURRENTS IN ELECTRICAL TRAMWAYS.

By JOHN GRAY, B.Sc., in the Electrical Review.

THE discovery that the earth cannot be safely used for the transmission of large return currents has been one of the unexpected outcomes of the extension of electrical tramways in towns. The gas and water mains, armored cables, etc., in every large town form a network of uninsulated conductors everywhere in contact with the earth, and any current flowing between two points on the earth's surface will be partly carried by these underground conductors. At the surface of contact between the pipe and the earth, where the current enters the pipe, no harm is done; in fact, one would expect that the natural process of corrosion would be arrested or reversed, and the pipe surfaces brightened. But at the surface where the current leaves the pipe, corrosion will be accelerated by an amount proportional to the magnitude of the current leaving the pipes. The activity of this corrosion will depend to a certain extent on the moisture and salts in the soil, but in no case is it likely to be absent.

In the single trolley system, which has hitherto been most extensively adopted for working electrical tramways, the return currents are discharged from the car wheels to the rails, and as these are not insulated from the earth, the earth forms a shunt circuit with the rails returning to the power house, and takes a proportion of the return current depending on their relative conductivities. The amount of stray current carried by the earth and its buried pipes, etc., is by no means inconsiderable; it has been found to amount to as much as 40 to 50 per cent. of the total return current in tramway systems without rail feeders.

An extensive series of experiments has been made by Mr. Stuart Smith* on the gas and water pipes in San Francisco, to determine their potentials relative to each other and to the tramway rails. He found that there was a zone in the neighborhood of the power station where the pipes were positive to the rails, then a short neutral zone, and beyond that a zone—by far the largest—where the pipes were negative to the rails. The resistance of the pipes was found to be made up almost entirely of the resistance of their joints, the section of metal in the pipes having very little influence. This fact explains the unexpected result that the resistance of the gas pipes was found to be rather less than that of the water pipes; the joints of gas pipes having usually less resistance than those of water pipes. This discovery of Mr. Stuart Smith's, that the resistance of underground gas and water pipes is located almost wholly at their joints, has an important bearing on the remedies proposed for getting rid of electrolytic corrosion. In many of the proposed plans, the current in the pipes is increased instead of being diminished. Evidently at each high resistance joint a stray current will pass round the joint through the ground, and accelerate corrosion, where it leaves the pipe surface in front of the joint. Unless gas and water pipes have been laid down with joints of good conductivity, any effective scheme for reducing electrolytic corrosion in these pipes must reduce the current flowing in them to a minimum.

Although electrolytic corrosion from electric tramways is much less than sensational newspaper articles would lead us to believe, yet it is going on steadily, and may be expected eventually to cause much trouble. It is advisable, therefore, that steps should be taken from the first to obviate or minimize the damage done to neighboring property.

Mr. Wilkinson, in his "Notes on Electric Tramways in the United States and Canada,"* has given a sketch of the various phases which this question has gone through in practice in America. He says: "As the earth presents an almost infinite mass compared with the rails, it was assumed, in the first instance, that a return of least resistance would be secured by well earthing the negative poles of the dynamos. The coal bill, however, stimulated inquiry into the losses in transmission of electric energy. On many lines of five to ten miles, the voltage at the most distant section between trolley wire and rails was only 50 per cent. of that generated at the station. Some improvement was made by sinking deeper earths into moist soil and connecting the same to more distant points on the rails. But at the best this was unreliable and variable, and it was noticed that improvement was more marked when attention was turned to the rails themselves as the best return conductors." The conductivity of the rails was improved by bridging over the high resistance joints by iron and copper bonds. In the next stage, the rails were connected at intervals to the water and gas pipes, a step which created a satisfactory reduction of resistance in the return circuit, but led to a great increase of electrolytic corrosion and pitting of the gas and water pipes. To mitigate this action, the affected parts of the pipes were connected by cables to the negative poles of the dynamos. This led to the use of a supplementary wire consisting of a bare copper rod, laid between the rails and connected to the rails on each side of the fish plates. But, as this supplementary conductor made no allowance for the increase of the current as the power station was approached, it was considered better to adopt separate return feeders connected to the rails every 500 feet, these feeders being increased in section and number as the lines neared the generating station. These feeders were not insulated, and consequently they were only a partial improvement on the supplementary wire.

Mr. Wilkinson considers that the separate feeder system would completely get rid of the stray currents if they were insulated. He says: "Let the negative poles of the dynamos be connected to the rails direct by insulated cables, but not to the earth at the station, and the current will then be kept within the rails and return feeders. The only chance for current to pass to earth would be as a shunt round bond joints of high resistance or insufficient conductivity; and should this occur, it will only cause electrolytic corrosion at such joints, and not on underground pipes and cables." This view of Mr. Wilkinson's appears to be erroneous. There will still be a current from the pipes to the earth under the end of each feeder where it is connected to the rail. The corrosion will therefore not be got rid of by this plan, but only more widely distributed over the pipes. That, in itself, of course, is an advantage, but something more requires to be done.

Mr. Jenkin, in the discussion on Mr. Wilkinson's paper, pointed out that the only way in which we can completely get rid of stray earth currents when using earthed rails in the circuit is to maintain all parts of the rails at the same potential. This could be perfectly carried out only by using an infinite number of insulated rail feeders, which, of course, is out of the question in practice. Mr. Jenkin calculates that to keep within the Board of Trade limit of 7 volts P.D. between any two points of the rails, the insulated feeders would have to be connected to the rails at points two miles apart; or, if the rails were also utilized to carry part of the return current, at points half a mile apart.

Mr. Jenkin shows that there are two distinct ways in which the potential of the rails can be regulated at the return feeder points: 1. By adjusting the resistance of the return feeders so that they have all the same drop when equally loaded. 2. By working the return feeders at the same density, and therefore with a drop depending directly on their length. In the first case the return feeders are run in parallel at the station off dynamos in parallel; in the second case, the feeders must be run off separate dynamos at different voltages, or some device must be used to vary the voltage. Calculations show that feeders worked on the uniform density principle are the cheapest, but lead to more complicated apparatus in the station than the other system.

This system, though more perfect than Mr. Wilkinson's, does not completely get rid of electrolytic corrosion, since there will always be numerous points near the ends of the feeders where the pipe systems are positive to the rails, and where they will, in consequence, discharge current to the earth. To get over this difficulty, a simple plan has been introduced by Harold P. Brown,† which is considered by Mr. Edison to be the only satisfactory method of preventing electrolytic corrosion in connection with electrical tramways. Mr. Brown's plan is to keep all parts of the underground pipes at least a few volts below the rails and the surrounding earth. If this is carried out there can, of course, be no current passing anywhere from the pipes to the earth, and consequently no electrolytic corrosion of the pipes. Mr. Brown attains his object by connecting the pipe systems near the power house by an insulated feeder to one of the dynamos with a voltage 12 volts in excess of the normal voltage of the other dynamos whose negative terminals are connected to the nearest point of the rails. This has the effect of keeping the pipes near the power station a few volts below the rails above them, and, of course, puts the potential of pipes still further off, below that of the rails by a greater amount. The drawback to this plan is that it considerably increases the flow of current in the pipes, and thereby increases corrosion at high resistance joints. Mr. Brown obviates this somewhat by prolonging his insulated feeder and connecting it to the rails at their most distant point, whereby the great difference of potential between the rails and the pipes at that point is reduced, and the consequent flow of current through the pipes. Though this system is cheap, and considerably reduces corrosion, there must still be a considerable current in the pipes, and, in view of the results of Stuart Smith's experiments already mentioned, this must always produce considerable corrosion in the course of time at the pipe joints. A combination of Mr. Brown's system with the equipotential rail system proposed by Mr. Jenkin would lead to an improvement on both systems, as only the comparatively small stray currents between the feeder ends would be collected in the pipes, and harmlessly drawn off by Mr. Brown's clamp and insulated feeder.

By such devices, there can be no doubt that electrolytic corrosion of pipes, if not completely eliminated, can be very much reduced. Whether the steady action of these reduced stray currents for many years will increase the natural rate of corrosion of pipes, etc., to such an extent as will give the companies concerned a claim for damages, remains to be seen. Up to the present there is no sufficient evidence that this is the case. The legal decisions, such as that in the case of the telephone company and the Leeds Corporation, appear to protect the tramway companies, provided they adopt the best means known for preventing damage by earth currents. If future developments should induce either the Board of Trade or the courts to demand the entire suppression of stray currents, electrical tramway companies can always fall back on the double trolley system, or some similar system in which no part of the circuit is in connection with earth.

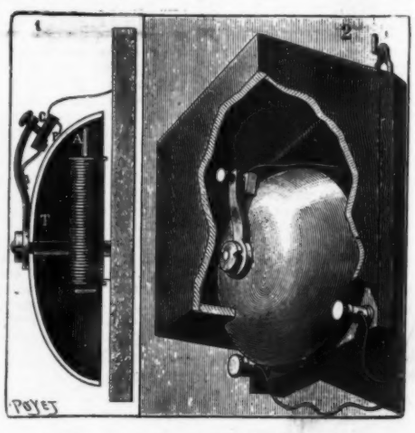
* Electrical World, vol. 35, No. 12.

* Journal Inst. Elec. Engs., vol. 23, p. 631.

† Electrical Review, April 19, 1895.

THE SINGING ELECTRIC BELL.

THREE centuries ago the father of Montaigne, desiring to spare his son's nerves, had him awakened to the sound of soft music, and yet our ancestors of that epoch were far from the deplorable state into which modern life has put the nervous systems of most of us.



THE SINGING ELECTRIC BELL.

An unexpected and strident noise irritates us, an electric bell or a telephone call sometimes makes us start, and there is no one who has not more than once desired a less atrocious method of attracting his attention.

The inventor of the apparatus that we are about to describe, Mr. Guerre, an electrician, of Paris, has solved the problem in the simplest and most elegant manner. For the bell with a hammer and a spring interrupter, he substitutes a steel bell which is its own interrupter. An electro-magnet, A (No. 1 of the figure), is placed in the interior of the bell, T, in such a way that its extremities come into immediate proximity with its wall. A small platinum point, P, fixed to a block of ebonite, C, leads the current to the bell, which transmits it to the rod to which it is fixed. Thence, the circuit continues through the bobbin and returns to the battery.

If the circuit be closed, the edge of the bell is immediately attracted and its support bends slightly, while, at the same time, the bell itself curves in closing. The contact is interrupted and the system returns to its starting point, and so on until the vibrations of the bell have reached an amplitude sufficient to produce a free interruption of themselves. The rod then ceases to be concerned in the vibration, and tha bell alone continues to vibrate under the action of the electro-magnet in giving a continuous musical sound quite similar to that obtained by rubbing the edge of a glass with the finger. The regulation of the interrupter is naturally the essential condition for the proper operation of the apparatus. In order to render this possible, the block of ebonite, C, is carried by a stiff spring, the position of which is fixed by means of a very firm screw so as to obtain a maximum of action of the bell. No. 2 of the figure represents the apparatus in its sounding box.—La Nature.

MAGNETIC TESTER FOR SHEET IRON.

THE award of a royal medal by the Royal Society to Professor Ewing for his work on magnetization effects recalls the paper which he read to the members of the Institution of Electrical Engineers at a meeting in the last session, entitled "A Magnetic Tester for Measuring Hysteresis in Sheet Iron." The author having stated that transformer makers find the great importance, from the point of view of all-day efficiency, of using sheet iron in which the hysteresis losses are small, referred to the wide differences exhibited in this respect by different samples of iron as shown by the ballistic and other methods of testing. What was wanted, he considered, was a sufficiently large number of tests in any one batch of iron to allow of a fair average to be estimated for the quality of the batch. The ballistic method, although unimpeachable on the point of accuracy, was anything but expeditious, and could scarcely be called simple. The apparatus devised by the author measures the hysteresis directly by a single operation, and in a manner sufficiently simple to permit of the test being applied to many specimens without taking up much time, trouble or iron. The instrument is based upon the mechanical measurement of the work done in causing reversals of magnetism to take place in the iron under examination. The instrument is brought forward as a practical tester for workshop use. The process of reversal resembles that which occurs in a transformer rather than in a dynamo, and the induction is caused to have practically the same value in all samples. The samples to be tested are cut in a simple form, and are arranged to be readily inserted and removed. The reversal of the magnetism is effected by turning a handle, and the result is indicated by the position of a pointer on a scale. The iron samples are cut or stamped in the form of strips 3 in. long, ⅝ in. wide. The sample is composed of six or seven of these strips for the usual gages of transformer iron, while a smaller number is used if the material tested is the thicker sheet used in dynamo armatures.

The magnetic tester consists of a permanent magnet arranged vertically and swinging about a knife edge working in an agate trough, a lifting arrangement being provided like that of a balance, so as to save the knife edge from unnecessary wear and tear. The pointer, which is carried by the upper part of the magnet, is set to zero in the middle of the scale by means of a nut which runs on a screw projecting sideways from the middle of the magnet, and a more delicate adjustment of the zero may be effected by means of a leveling screw. The bundle of iron strips constituting the sample to be tested is placed in a carrier and is covered with a vulcanite washer and secured by two clamps. The carrier is made to rotate by means of a friction pulley and hand driving wheel. This causes the sample to revolve between the poles of the magnet, with the effect that its magnetism is periodically reversed. The work done in reversing the magnetism in consequence of hystersis causes a mechanical moment to be exerted by the revolving sample upon the magnet, and the latter, owing to its support by the knife edge previously mentioned, and which is in line with the axis of the carrier, tends to follow the sample, and is deflected through an angle which serves to measure the work expended. Since a definite amount of work is done per reversal, the deflection of the field magnet is independent of the speed at which the carrier revolves, and no special care has to be taken to turn the handle of the driving wheel at a uniform rate. The swinging of the magnet is checked by a dash pot below, and the stability is adjusted to give any required degree of sensitiveness. The operation of testing is effected by the insertion of the sample, and after reading the deflection of the pointer to one side, the observer reverses the direction of rotation, reads the deflection to the other side, and takes the sum of the two readings as the total deflection. The deflection is proportional, or approximately so, to the hysteresis of the iron, even when a comparison is made of samples widely different in quality. To insure that this shall be so, a considerable air space is left between the magnet poles and the ends of the sample, with the result that such variations of permeability as are liable to be met with in different samples of iron are almost without influence upon the total induction through the iron. The dimensions and strength of the field magnet are so proportioned with reference to the section of the sample and to the extent of the air gaps as to cause the induction to have a value fairly representative of transformer work. In the tester exhibited in operation to the meeting, the induction is about 4,000 C. G. S. units, with the normal size of test sample. By increasing or reducing the area of section of the sample the intensity of the induction is reduced or increased. Within reasonable limits, however, any value of this intensity may be adopted in testing.

If a weight of a sample chosen is equal to that of seven pieces of this material as a general standard, it will suffice, in preparing other samples for testing, to select that number of strips which will give a weight approximating even roughly to the standard weight. The nearest whole number of strips will do, and it is necessary to cut a narrow or wide strip to make up the exact weight. Discussing the question of calibration, an exhaustive series of experiments has been made to determine to what degree of accuracy the readings of the magnetic tester correspond to the hysteresis losses as found by ballistic tests for various samples of iron. A comparison showed that both accord well to one another and that the scale reading of the magnetic tester is nearly proportional to the hysteresis loss. The hysteresis of the standard samples is stated for B = 4,000. To find the hysteresis for any other induction, it is only necessary to use a table of factors given in the paper, and deduced by the author as a general mean from ballistic tests of many samples. In conclusion the author said that the instrument could be constructed in various ways, and that his object had been to facilitate testing by makers of plates and transformers, and by engineers of alternating current supply stations.

THE large artesian well recently sunk at Chamberlain, S. D., is now at work running the electric light and power plant in that town. The water is utilized through a 3 inch nozzle, playing upon a Pelton water wheel. The present plant supplies 275 32-candle power incandescent lamps, but there is sufficient reserve power to run double this number.

NEW TRIPLE EXPANSION PUMPING ENGINES.

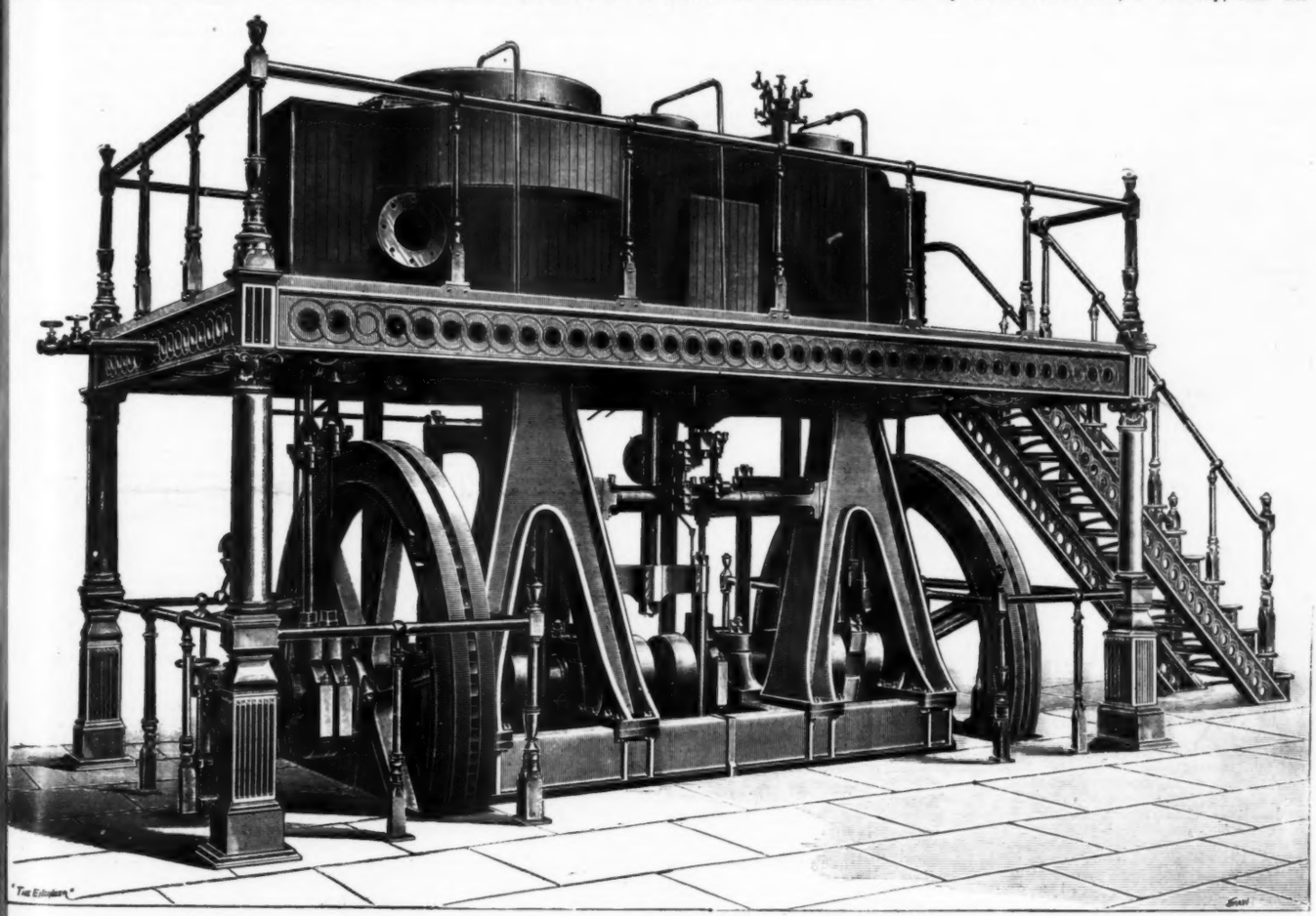
THE new pumping engines for the waterworks of Leicester, England, are of the triple expansion type. They were erected by Messrs. Easton, Anderson & Goolden, of Erith, Kent. We are indebted to Engineer for the cut and copy. The valve gear is of the ordinary slide type, having the maker's improved Meyer expansion gear fitted to all cylinders, and capable of being adjusted by hand while running for each cylinder separately, and so designed that the cut-off, both top and bottom, is for all grades practically equal, in which it differs from the ordinary Meyer gear. The cylinders are jacketed by liners. The pumps are of the plunger type, driven direct from the piston rod of each cylinder, with a return connecting rod on to the three-throw crank shaft of the engine, on either end of which is mounted a fly wheel. The pump valves are of the ring type, the seats and rings being of gun metal.

The fly wheel shaft is in the center between the steam cylinders and the rams, and is actuated by connecting rods working in the hollow rams, these being coupled direct by a pair of rods to the crossheads below the steam cylinders. The whole forms a very compact and neat arrangement, and the engines are highly finished.

Steam is supplied to the engine by a pair of Lancashire boilers, each 30 ft. long and 7 ft. diameter, made by Mr. Edwin Danks, of Oldbury, near Birmingham. The leading particulars of the engines are as follows:

Diameter of high pressure cylinder	17 in.
" " intermediate "	27 in.
" " low pressure "	44 in.
Length of stroke	36 in.
Revolutions per minute	25
Steam pressure	120
Indicated horse power, about	150
Diameter of pump plungers, Cropstone	13¾ in.
Diameter of pump plungers, Swithland	12¼ in.
Maximum head of water in feet, Cropstone	278 ft.
Maximum head of water in feet, Swithland	378

Considerable difficulty was experienced in putting in the foundations, as trial shafts and borings showed that for a depth of upward of 37 ft. the subsoil consisted of loose running silt, and as the existing buildings and engines were upon the same bed, the greatest care had to be exercised so as not to disturb the existing work. Sheet piling 6 in. thick, and tongued with wrought iron, was driven to a depth of 24 ft., and made watertight and strongly timbered inside. The sand and silt was then taken out and bottomed in short lengths to a depth of 20 ft., and replaced by a bed of cement concrete 8 ft. thick, upon which the buildings and engines have been erected. These precautions proved satisfactory, as neither during the putting in of the foundations nor subsequently has any settlement been detected in the existing buildings and machinery.



NEW TRIPLE EXPANSION PUMPING ENGINES.

ENGINEERING NOTES.

IT is to the underground system that London must look for the solution of its transportation problems. The existing South London Railway is being extended at both ends. The Central London Railway covers a route over which there is an estimated daily traffic of over 225,000. The proposed speed is 14 miles an hour, and the trains are to be run at 2-½ minute intervals. The work of tunneling for the City & Waterloo Railway will soon be completed. These two latter underground systems are modeled after the South London Railway, and they will be electrically worked. The absence of smoke, with electric lighting and an effective system of ventilation, have made travel on the South London road agreeable, as compared with the existing Metropolitan and District roads.

To make a rolled blue print lie flat, lay it upon a drawing board or table near the edge and draw one end of the paper down sharply over the edge of the table, at the same time holding the paper firmly down upon the table with the other hand. The whole sheet should be drawn across the edge in this way, and it will thus be bent back in a direction contrary to that in which it had been rolled. One or two repetitions will effectually correct the tendency to roll up.

Work is about to commence on the reconstruction of the Dismal Swamp Canal, which extends from Norfolk, Va., to Elizabeth City, N. C. The charter for the construction of the original canal, 48½ miles in length, was granted in 1787. The enlarged canal is to have a width of 60 feet and a uniform depth of 10 feet.

The Peninsular & Oriental Steamship Company, whose vessels ply between Great Britain and India, China, Japan and Australia, is distinguished by the success as well as the magnitude of its operations. In spite of a bill for operating expenses and additions to the fleet that was only a little short of $30,000,000, the company has recently declared a dividend of 10 per cent. There are over 60 vessels in the fleet.

There has been a very marked decrease in the cost of tunneling of late years. The Railway Review, commenting on this fact, rightly ascribes it to the great improvement that has been made in rock excavating tools and in general mechanical methods. According to the same journal, the Hoosac Tunnel cost $379 per foot; the Mont Cenis, the next in date, $356 per foot; the St. Gothard, $229 per foot; and the Arlberg, $154 per foot. The tunnel on the line of the Northern Pacific Railroad through the Cascade Mountains, 8,950 feet long, was bored at the rate of 413 feet a month at a cost for the completed tunnel of $118 per foot.

The 15 inch dynamite gun plant which has been erected at Fort Winfield Scott, San Francisco, was built from the designs of Mr. Edward A. Rix. According to a detailed account of the plant furnished to the Mining and Scientific Press by Mr. RIX, the guns weigh about 70 tons each, including the mountings. They are 50 ft. long and fire projectiles of any caliber between 8 and 15 in.

The difference between the full and the sub-caliber is made up by inclosing the shot in wooden jackets, which fly off as soon as the shot leaves the gun. The 8 inch shell carries 100 lb. of dynamite, and has a range of 5,000 yards. The 15 inch shell, which is 11 ft. long, carries 1,000 lb. of dynamite and has a range of over 2,000 yards.

In the tests for accuracy, the government requirements were exceeded, the 8 inch shells being placed within a target 70 yards long by 30 yards in width at a range of 5,000 yards. The projectiles contain a nitrogelatine, composed mainly of nitroglycerine and guncotton; and the 15 inch shells cost $1,000 each. The enormously destructive effect of these guns is shown by the fact that in the tests a 15 inch shell, at a distance of 2,000 yards, threw up a column of water 100 ft. in diameter to a height of over 350 ft.! The firing mechanism of the shells is so arranged that they can be exploded by direct impact, by side impact, or after a delay of a few seconds.

The activity in the Devonport Dockyard shows no signs of diminishing. There are about 2,000 men working overtime, and the weekly wages paid out amount to $40,000, or 25 per cent. in excess of the naval estimates. Tenders have just been invited for ten new third-class cruisers. They are to be of 3,000 tons displacement and twenty knots speed, and steam will be furnished by water-tube boilers. The armament will be of the quick-firing pattern. According to Engineering, these ships are expected to be completed in a little over 12 months.

Prof. Boys has recently exhibited at London a series of photographs of the Lee-Metford bullet as it passes through a ¼ inch sheet of glass. Just before the bullet touched the sheet, the air wave cut a disk of glass one-half the diameter of the bullet clean out. At the same time the glass round the hole made was crushed into powder, and driven backward. The glass stuck to the bullet for a short time after it had passed through, the disk being driven on in front of the "bow wave." A photograph of the bullet after it had cleared the glass by 9 inches showed the remainder of the glass intact. When the bullet had proceeded another 16 inches, the sheet of glass was seen to break and fall to pieces.—Army and Navy Journal.

There has been a steady decrease in the cost of railroad transportation in the United States during the past thirty years. An estimate of the cost of transporting one ton of freight on thirteen of the leading roads shows that it has decreased from $3\frac{9}{10}$ cents in 1865 to $\frac{7}{10}$ cent in 1893. This country enjoys a wide reputation for the cheapness and excellence of its railroad freight service; and it is safe to say that while the English freight trains run at a higher average speed, they are far behind the United States practice in point of economy.

ELECTRICAL NOTES.

IT is likely that currents of extreme frequency will be extensively used in the treatment of diseases due to impaired nutrition. By passing such currents through solenoids, which entirely surrounded the patient, very remarkable therapeutical effects were secured. The experiments, which were carried out by Drs. Apostoli and Berlioz, embraced two classes of diseases. No results were observed in the case of hysterical patients, or those suffering from neuralgia. In the case of persons suffering from gout, rheumatism and glycosuria there were very marked beneficial results. The first effect to be noted was a general improvement in the condition of the patient. Oxidation, moreover, was "invariably increased, as urinalysis showed." Twenty electrizations caused glycosuria to completely disappear in the case of three diabetic patients.

Electric heating on a large scale is to be tried in the Carmelite Monastery which is situated near the Niagara Falls Electric Works. The same agent is to be utilized for general domestic purposes, such as cooking and laundry work and for general power purposes. This attempt to utilize electric heating on so large a scale will furnish some much needed comparative data. Hitherto electric heating, as tried on trancars, has shown an increased cost over other methods.

The records of the Patent Offices show that in 1894 there were 1,704 electrical patents allowed in the United States, 1,394 in Great Britain, and 481 in Germany.

It is estimated by Mr. Frank J. Sprague that there are "not less than 5 000 elevators of various kinds in New York City; more, in fact, than there are street cars, and more people are carried vertically than there are horizontally."

As the result of some tests to ascertain the tractive force required for various forms of tricycle, Mr H. W. Ravenshaw, in a communication to London Engineering, states that with accumulators giving 6 ampere hours per pound it ought to be possible to make carriages weighing not more than 250 pounds, which could carry two persons 40 miles without recharging.

The Electrical World gives some remarkable results of a test of incandescent lamps of high economy. The tests were carried out at the laboratory of Messrs. Stone & Webster, Boston, the subject of the tests being the "Imperial" lamp made by the Bryan Marsh Company. The aim of the manufacturers is to produce a lamp "of practically constant illumination after the initial fall." The lamps were tested on a 600 hours run, and they fell less than two candle power during the last 400 hours, finishing at an average slightly above 15 candle power. The average efficiency was slightly less than 3·5 watts. If these results can be obtained in everyday practice under like conditions, we may look for considerable economies of great value to central stations.

The Mount Snaefel Railway, in the Isle of Man, recently opened, is 4¾ miles long and is built on an 8 per cent. grade. The motor cars are 35 ft. long and 7 ft. 3 in. in width, and can carry forty-eight passengers, according to the Street Railway Journal. A novel feature in the construction of the track is a single line of double-headed rails, of the common English pattern, which is laid on chairs of such a height as to bring it slightly above the level of the outer rails. This third rail is laid on its side. Flanged wheels, which are attached to the car, bear against this rail on either side, and an emergency brake is provided which grips the rail under the action of a powerful screw. A large accumulator station is provided for equalizing the load on the generating stations. The accumulators are charged by the spare current when the load is light, and they automtically distribute their energy when the load rises above a certain point.

Commenting on the year's progress in the applications of electricity, Industries and Iron says editorially: "While this country" (Great Britain) "as a whole is behind some others in the general applications of electricity, yet we are excelled in none as regards the perfection of the systems in operation, exemplifying, as most of them do, the latest development of modern practice. This is an advantage which, perhaps, counterbalances, in part, that somewhat exaggerated conservatism of which it is the issue." While admitting that English practice may offset in some measure the limited sphere of its operations by its general excellence, it is startling to read in the next sentence that "only about one hundred towns and cities in the United Kingdom have established, or have in progress, an electric supply station." Judged in the light of the fact that in this country there is many a little town of less than 2,000 souls that can boast of an electric station, this paucity of such installations in the United Kingdom may well be attributed to an "exaggerated conservatism."

A powerful electrically driven bar shear for cutting up heavy scrap has recently been built by the Hilles & Jones Co., of Wilmington, Del. It can shear flat or round bars up to 16 square inches of section. It is driven by a multipolar ironclad motor, and according to Locomotive Engineering, the lines of the machine are very massive, the spur gear being of 3½ inches pitch and 10 inch face, the weight of the complete machine being about 45,000 pounds.

Mr. Hiram S. Maxim is of the opinion that with suitably designed rolling stock, running upon separate tracks specially laid for high speed, it would be possible to run electrically propelled trains at a rate of between 90 and 120 miles an hour. According to this scheme the local and freight traffic would be handled, as now, by steam locomotives, the special tracks being reserved for the fast through electric trains. The problem, as compared with steam traction, is largely one of comparative cost.

MISCELLANEOUS NOTES.

THE absolute necessity for the adoption of the metric system of weights and measures is at last being realized by the British empire. A parliamentary committee has recommended that the system be made compulsory two years after the passage of a bill to that effect. British standards have always been an inconvenience to commerce at home and a positive loss abroad, where it has to meet German and Belgian competition.

A preparation of asbestos wool, compressed into thin sheets by hydraulic pressure, is being used for the middle soles of boots. These sheets are rendered waterproof on one side by the application of a special solution. The inventor claims that this combination of a non-conducting and waterproof material in the sole of a boot will protect the wearer from the effects of heat, cold or moisture.

The fund for the erection of a statue in Paris to the memory of the late Louis Pasteur has received a subscription of $2,000 from the French government. The surplus over the expense of the statue is to be spent upon a bust of the eminent scientist, which will be placed in the Pasteur Institute. Statues to his memory are to be erected in Chartres and in Dôle, the birthplace of Pasteur. A Société Pasteurienne has been formed, having for its object the building and management of hospitals on the model of the Pasteur Institute.

The Lumber Trade Journal speaks of a floating sawmill which is being built at Pensacola for work on the Escambia River. It seems that during the past fifty years in which logs have been rafted down this river many of them have from time to time sunk, and are now lying on the river bed. For about sixty miles they are strewn along the bottom. The right to the lost logs has recently been purchased at a nominal figure; and the purchasers propose to grapple for them, and saw a slab from each of the four sides of the logs, using the floating sawmill for this purpose.

In the January Bulletin of Cornell University Agricultural Experiment Station Mr. M. V. Slingerland gives the results of his experiments directed to the extermination of wireworms and the bud moth. The true wireworms are the young of click beetles or snapping bugs. The system of protecting the seed by coating it with various substances was exhaustively tested, nine of the various coatings and solutions which are commonly in use among farmers being tried. Other methods that were tested were: Starvation by clean fallow; starvation by supposed immune crops, or crops distasteful to the wireworms, and destruction by insecticides. The destruction of the click beetles themselves was tested, first by fall plowing and again by trapping. The report says: "For three years we did our best, and we failed to discover a single satisfactory method of protecting seed, or of destroying miniature wireworms in the soil. We did learn, however, what cultivation will destroy the wireworms ready to pupate, the pupæ and the beetles. We also learned that many commonly recommended plans are useless. Such a short rotation of the crops as will include a period of thorough cultivation in the fall will prove the best method of fighting these pests yet suggested." The bud moth, the most injurious insect present in the New York orchards, is an importation from Europe. This pest "can best be reached with an arsenical spray applied frequently and thoroughly. It will necessitate at least two thorough applications before the flowers open."

In England last year 5,581 new books were published, 281 more than in 1894, but the number of new editions fell off, so that the total number of publications, 6,516, was but 31 above the previous year. Of the new books 1,544 were of fiction, 231 of poetry and drama, 501 theological, 660 educational, 359 of science and travel, 353 historical. With the new editions there were 1,891 novels, stories, etc., published—six a day for every working day in the week.

The Digest of Physical Tests and Laboratory Practice gives a statement by Traulionie of the tensile strength of glass as being from 2,500 to 9,000 pounds per square inch; crushing strength, 6,000 to 10,000 pounds per square inch; and the transverse strength as established by his own trials at Millville, N.J., showed that a bar of flooring glass one inch square and one foot between end supports breaks under a load of 17[illegible] pounds; consequently, it is stronger than granite except as regards crushing, in which the two are about equal. It is suggested that glass will shortly be used for many purposes where other and much inferior materials are still exclusively employed. Glass may be used as water conduits to better advantage than cast iron or terra cotta, as it is impervious to moisture and proof against corrosion or chemical action. It is already considerably in use for flooring, and it has lately been successfully experimented with for railway sleepers under exceptionally severe conditions.

At a recent sitting of the rapid transit commissioners in New York City some interesting statistics of pedestrian traffic on Broadway were presented. They were gathered by Steward E. DeWitt, on three different days in December, between the hours of 7 a. m. and 7 p. m. At a place between Twenty-first and Twenty-second Streets, he counted 6,500 passing vehicles and 14,460 persons on the east sidewalk and 53,807 on the west sidewalk. Between Chambers and Vesey Streets he counted 5,150 vehicles between 7 a. m. and 7 p. m., and between 7 a. m. and 7 p. m. there passed 38,805 persons on the east sidewalk and 41,530 on the west. Between Fulton and John Street there passed 8,630 vehicles, with 59,360 pedestrians on the east and 50,600 on the west walk.

The family of the late Professor Daniel Cady Eaton have presented his valuable herbarium to Yale University. The collection, which is largely composed of North American ferns and mosses, contains more than 65,000 sheets.

THE SCIENCE OF SOCIAL STATISTICS.

POPULATION.

THE Hon. Carroll D. Wright, United States Commissioner of Labor, delivered, on January 31, in New York City, the second of a course of lectures at the School of Social Economics, the subject of the course being the Science of Social Statistics and Their Application to Industrial Subjects. The course promises to be an exceedingly valuable one to students of social economics, Mr. Wright being the most experienced statistician in the United States and an expert in this line of world-wide reputation.

In introducing the subject of population, the lecturer stated that statisticians claim that in the complicated work of gathering statistics "errors offset themselves;" and it has been found that variations from fact will lie as often on one as on the other side of the true line. The mere count of the people of the United States in the census of 1890 was "fairly accurate." It was made by an army of 50,000 enumerators, who were provided with schedules containing twenty-seven distinct questions. To each enumerator was assigned a district, and he was supposed to call at every house in his district and fill in the schedule from information furnished by the head of the household. The chief liability to error under this system arises from the fact that it will often happen that the head of the family is not at home when the call is made, and possibly there may be no one but the domestic to answer the queries. Manifestly, a schedule embodying many details of the family history and its present condition will be very imperfectly filled in from such a source.

In Great Britain they use what is known as the photographic census. On a particular Saturday night, prearranged, blank schedules are left at each house throughout the country, with the request that they be filled in by the head of the family. These are subsequently collected by enumerators and sent to the home office. The lecturer was of the opinion that the American system was better, for the reason that the data are gathered in response to personal questioning. On the other hand, the American enumerator is paid two cents per head for all whom he questions, and this premium is conducive to error for the reason, first, that the enumerator is tempted to return a larger total than he has actually questioned; and, secondly, that he is apt to be too hurried and superficial in his work.

The advantage lies on the side of the American system. The enumerator is brought into personal contact with the people; he acquires experience, and he becomes expert in drawing out the proper facts and detecting error in the replies that are given.

Mr Wright had made a test, on one occasion, of the English system in the State of Massachusetts, with the result that only 27 per cent. of the schedules were properly filled in.

The census of 1890 showed a total population for the United States of 62,060,000 people.

INCREASE OF POPULATION PER CENT.

	Native.	By Immigration.
1830–1840	28·87	4·65
1840–1850	26·15	9·68
1850–1860	23·73	11·38
1860–1870	15·40	7·25
1870–1880	22·79	7·29
1880–1890	14·40	10·46

It will be noticed that in the decade 1860 to 1870 there is a great falling off in the normal rate of increase of the native population. This is attributed to the destructive effect of the war of the rebellion, the difference between the actual and the normal increase for this decade representing the loss by death and the loss due to the breaking up of families and the general upheaval of society. The decade 1880 to 1890 falls even more below the normal, and for this there is no assignable cause. Although a variety of causes have been suggested, it is to-day a standing puzzle to statisticians. In the discussion which followed the close of the lecture it was suggested that the evident growing tendency to restrict the size of families and the possible relative decrease in the number of marriages would explain the falling off.

The proportion of males to females is very even. The popular notion that females greatly outnumber males is erroneous, as shown by the following table:

FEMALES TO 1,000 MALES.

United States	952
United Kingdom	1047
France	1014
Germany	1039
Russia	1027
Austria	1044
Italy	995
State of Massachusetts	1058
State of Montana	503

The last two figures in the table show how largely the proportion is affected by local industries. The abundance of textile industries which employ a large amount of female help is shown in the figures for Massachusetts; and the mining interests of Montana produce a preponderance in that State of male population of two to one.

PROPORTION OF FOREIGNERS TO EACH 1,000 IN VARIOUS COUNTRIES.

United Kingdom	4
France	29
Germany	10
Austria	17
Italy	2
Switzerland	78
Belgium	26
United States	149

The high percentage in Switzerland is caused by the large number of invalids, visitors, etc., who settle permanently in the country.

PROPORTION OF VARIOUS CLASSES OF FORKIGNERS TO TOTAL FOREIGN POPULATION IN UNITED STATES.

English and Welsh	10·91
Irish	20 23
Scotch	2·62
German	30·11
French	1·22
British American	10·61
Scandinavian	10·09
All others	14·21

The small number of French immigrants is to be attributed to the fact that the French are not colonizers; but the small proportion of Scotch immigrants will be something of a surprise. The total number of foreigners in the United States in 1890 was 9,249,547.

PROPORTION OF NATIVE TO FOREIGN POPULATION IN VARIOUS OCCUPATIONS.

	Native.	Foreign.
All occupations	77·07	22·93
Agriculture, fisheries and mining	85·26	14·74
Professional	87·78	12 22
Domestic	67·01	32·99
Trade and transportation	78·22	21·78
Manufactures	68·44	31·56

The greater part of the Irish born population is found to the east of Pittsburg, and of the German and Scandinavian to the west of that city. This statistical fact is in keeping with the tastes and habits of these races; the Irish turning, as a rule, to the industries of their adopted country and the Germans and Scandinavians to agriculture

It is a startling fact that 44 per cent. of the population of the State of North Dakota is foreign born, chiefly Scandinavian and German. The science of statistics can throw much light upon questions of social economy, as in the case of the make-up of population of the State of Dakota, above mentioned, compared with that of the State of North Carolina, where $\frac{2.2}{100}$ of one per cent. only of the population is foreign born. Such a comparison shows conclusively that our country is not homogeneous, and that the laws of one State must, of necessity, vary from those of another.

The statistics of immigration which have been gathered from the Custom House returns show that between the years 1821 and 1890, 15,427,657 immigrants entered the United States, and this does not include those coming from Canada and Mexico. Of this number, 9,249,547 or 60 per cent. were living in 1890.

The center of population is steadily moving to the westward. In 1790 it was situated in Boston. Since then it has traveled 500 miles to the westward, keeping very close to the 39th parallel, and to-day it is situated near Indianapolis.

The proportion of city to country population has grown rapidly in the United States in the past thirty years, the percentage now being 39. This, however, is small as compared with that of some European countries.

PROPORTION OF COUNTRY TO CITY POPULATION.

	Per cent.
Holland	80
Belgium	64
England and Wales	61
Scotland	61
Ireland	19
German empire	41
Switzerland	44
United States	39

The lecturer does not share the fear which has been expressed in many quarters that the cities are being recruited at the expense and to the detriment of the country.

A large proportion of these city dwellers should more strictly be called suburban. Every year there are a large number of people who move from the remote country districts, and settle in the outer suburbs of our large cities. In this way they retain all the undoubted advantages of country life; the separate home, the surrounding fruit and flower garden, the freedom and quiet, and the fresher, purer atmosphere, and at the same time they are within touch of the benefits of city life. The tendency to extend the city limits by annexation of vast outlaying districts, as in the case of Chicago, which has a full stretch of thirty miles, causes this ultra-urban population to be returned in the city census, and causes the proportion of the city dwellers to appear larger than in the strictest sense of the term it can be said to be.

ORIGINAL MEMOIR OF PROF. ROENTGEN.

"ON A NEW KIND OF RAYS."*

1. A DISCHARGE from a large induction coil is passed through a Hittorf's vacuum tube or through a well exhausted Crookes or Lenard tube The tube is surrounded by a fairly close fitting shield of black paper; it is then possible to see, in a completely darkened room, that paper covered on one side with barium platinocyanide lights up with brilliant fluorescence when brought into the neighborhood of the tube, whether the painted side or the other be turned toward the tube. The fluorescence is still visible at two meters distance. It is easy to show that the origin of the fluorescence lies within the vacuum tube.

2. It is seen, therefore, that some agent is capable of penetrating black cardboard which is quite opaque to ultra violet light, sunlight, or arc light. It is therefore of interest to investigate how far other bodies can be penetrated by the same agent. It is readily shown that all bodies possess this same transparency, but in very varying degrees. For example, paper is very transparent; the fluorescent screen will light up when placed behind a book of a thousand pages; printer's ink offers no marked resistance. Similarly the fluorescence shows behind two packs of cards; a single card does not visibly diminish the brilliancy of the light. So, again, a single thickness of tinfoil hardly casts a shadow on the screen; several have to be superposed to produce a marked effect. Thick blocks of wood are still transparent. Boards of pine two or three centimeters thick absorb only very little. A piece of sheet aluminum, 15 mm. thick, still allowed the X rays (as I will call the rays, for the sake of brevity) to pass, but greatly reduced the fluorescence. Glass plates of similar thickness behave similarly; lead glass is, however, much more opaque than glass free from lead. Ebonite several centimeters thick is transparent. If the hand be held before the fluorescent screen, the shadow shows the bones darkly, with only faint outlines of the surrounding tissues.

Water and several other fluids are very transparent. Hydrogen is not markedly more permeable than air. Plates of copper, silver, lead, gold, and platinum also allow the rays to pass, but only when the metal is thin. Platinum 0·2 mm. thick allows some rays to pass; silver and copper are more transparent. Lead 1·5 mm thick is practically opaque. If a square rod of wood 30 mm. in the side be painted on one face with white lead, it casts little shadow when it is so turned that the painted face is parallel to the X rays, but a strong shadow if the rays have to pass through the painted side. The salts of the metals, either solid or in solution, behave generally as the metals themselves.

3. The preceding experiments lead to the conclusion that the density of the bodies is the property whose variation mainly affects their permeability. At least no other property seems so marked in this connection. But that the density alone does not determine the transparency is shown by an experiment wherein plates of similar thickness of Iceland spar, glass, aluminum, and quartz were employed as screens. Then the Iceland spar showed itself much less transparent than the other bodies, though of approximately the same density. I have not remarked any strong fluorescence of Iceland spar compared with glass (see below, No. 4).

4. Increasing thickness increases the hinderance offered to the rays by all bodies. A picture has been impressed on a photographic plate of a number of superposed layers of tinfoil, like steps, presenting thus a regularly increasing thickness. This is to be submitted to photometric processes when a suitable instrument is available.

5. Pieces of platinum, lead, zinc, and aluminum foil were so arranged as to produce the same weakening of the effect. The annexed table shows the relative thickness and density of the equivalent sheets of metal:

	Thickness. Mm.	Relative Thickness.	Density.
Platinum	0·018	1	21·5
Lead	0·050	3	11·3
Zinc	0·100	6	7·1
Aluminum	3·500	200	2·6

From these values it is clear that in no case can we obtain the transparency of a body from the product of its density and thickness. The transparency increases much more rapidly than the product decreases.

6. The fluorescence of barium platinocyanide is not the only noticeable action of the X rays. It is to be observed that other bodies exhibit fluorescence, e. g., calcium sulphide, uranium glass, Iceland spar, rock salt, etc.

Of special interest in this connection is the fact that photographic dry plates are sensitive to the X rays. It is thus possible to exhibit the phenomena so as to exclude the danger of error. I have thus confirmed many observations originally made by eye observation with the fluorescent screen. Here the power of the X rays to pass through wood or cardboard becomes useful. The photographic plate can be exposed to the action without removal of the shutter of the dark slide or other protecting case, so that the experiment need not be conducted in darkness. Manifestly, unexposed plates must not be left in their box near the vacuum tube.

It seems now questionable whether the impression on the plate is a direct effect of the X rays or a secondary result induced by the fluorescence of the material of the plate. Films can receive the impression as well as ordinary dry plates.

I have not been able to show experimentally that the X rays give rise to any calorific effects. These, however, may be assumed, for the phenomena of fluorescence show that the X rays are capable of transformation. It is also certain that all the X rays falling on a body do not leave it as such.

The retina of the eye is quite insensitive to these rays: the eye placed close to the apparatus sees nothing. It is clear from the experiments that this is not due to want of permeability on the part of the structures of the eye.

7. After my experiments on the transparency of increasing thicknesses of different media, I proceeded to investigate whether the X rays could be deflected by a prism. Investigations with water and carbon bisulphide in mica prisms of 30° showed no deviation either on the photographic or the fluorescent plate. For comparison, light rays were allowed to fall on the prism as the apparatus was set up for the experiment. They were deviated 10 mm. and 20 mm. respectively in the case of the two prisms.

With prisms of ebonite and aluminum, I have obtained images on the photographic plate which point to a possible deviation. It is, however, uncertain, and at most would point to a refractive index 1·05. No deviation can be observed by means of the fluorescent screen. Investigations with the heavier metals have not as yet led to any result, because of their small transparency and the consequent enfeebling of the transmitted rays.

On account of the importance of the question, it is desirable to try in other ways whether the X rays are susceptible of refraction. Finely powdered bodies allow in thick layers but little of the incident light to pass through, in consequence of refraction and reflection. In the case of the X rays, however, such layers of powder are for equal masses of substance equally transparent with the coherent solid itself. Hence we cannot conclude any regular reflection or refraction of the X rays. The research was conducted by the aid of finely powdered rock salt, fine electrolytic silver powder, and zinc dust already many times employed in chemical work. In all these cases the result, whether by the fluorescent screen or the photographic method, indicated no difference in transparency between the powder and the coherent solid.

It is, hence, obvious that lenses cannot be looked

* By W. C. Roentgen. Translated by Arthur Stanton from the Sitzungsberichte der Wurzburger Physik-medic. Gesellschaft, 1895.—Nature.

upon as capable of concentrating the X rays; in effect, both an ebonite and a glass lens of large size prove to be without action. The shadow photograph of a round rod is darker in the middle than at the edge; the image of a cylinder filled with a body more transparent than its walls exhibits the middle brighter than the edge.

8. The preceding experiments, and others which I pass over, point to the rays being incapable of regular reflection. It is, however, well to detail an observation which at first sight seemed to lead to an opposite conclusion.

I exposed a plate, protected by a black paper sheath to the X rays, so that the glass side lay next to the vacuum tube. The sensitive film was partly covered with star-shaped pieces of platinum, lead, zinc, and aluminum. On the developed negative the star shaped impression showed dark under platinum, lead, and, more markedly, under zinc; the aluminum gave no image. It seems, therefore, that these three metals can reflect the X rays; as, however, another explanation is possible, I repeated the experiment, with this only difference, that a film of thin aluminum foil was interposed between the sensitive film and the metal stars. Such an aluminum plate is opaque to ultra violet rays, but transparent to X rays. In the result the images appeared as before, this pointing still to the existence of reflection at metal surfaces.

If one considers this observation in connection with others, namely, on the transparency of powders, and on the state of the surface not being effective in altering the passage of the X rays through a body, it leads to the probable conclusion that regular reflection does not exist, but that bodies behave to the X rays as turbid media to light.

Since I have obtained no evidence of refraction at the surface of different media, it seems probable that the X rays move with the same velocity in all bodies, and in a medium which penetrates everything, and in which the molecules of bodies are embedded. The molecules obstruct the X rays the more effectively as the density of the body concerned is greater.

9. It seemed possible that the geometrical arrangement of the molecules might affect the action of a body upon the X rays, so that, for example, Iceland spar might exhibit different phenomena according to the relation of the surface of the plate to the axis of the crystal. Experiments with quartz and Iceland spar on this point lead to a negative result.

10. It is known that Lenard, in his investigations on cathode rays, has shown that they belong to the ether and can pass through all bodies. Concerning the X rays the same may be said.

In his latest work, Lenard has investigated the absorption coefficients of various bodies for the cathode rays, including air at atmospheric pressure, which gives 4·10, 3·40, 3·10 for 1 cm., according to the degree of exhaustion of the gas in discharge tube. To judge from the nature of the discharge, I have worked at about the same pressure, but occasionally at greater or smaller pressures. I find, using a Weber's photometer, that the intensity of the fluorescent light varies nearly as the inverse square of the distance between screen and discharge tube. This result is obtained from three very consistent sets of observations at distances of 100 and 200 mm. Hence air absorbs the X rays much less than the cathode rays. This result is in complete agreement with the previously described result, that the fluorescence of the screen can be still observed at two meters from the vacuum tube. In general, other bodies behave like air; they are more transparent for the X rays than for the cathode rays.

11. A further distinction and a noteworthy one results from the action of a magnet. I have not succeeded in observing any deviation of the X rays even in very strong magnetic fields.

The deviation of cathode rays by the magnet is one of their peculiar characteristics. It has been observed by Hertz and Lenard that several kinds of cathode rays exist, which differ by their power of exciting phosphorescence, their susceptibility of absorption, and their deviation by the magnet; but a notable deviation has been observed in all cases which have yet been investigated, and I think that such deviation affords a characteristic not to be set aside lightly.

12. As the result of many researches, it appears that the place of most brilliant phosphorescence of the walls of the discharge tube is the chief seat whence the X rays originate and spread in all directions; that is, the X rays proceed from the front where the cathode rays strike the glass. If one deviates the cathode rays within the tube by means of a magnet, it is seen that the X rays proceed from a new point, i. e., again from the end of the cathode rays.

Also for this reason the X rays, which are not deflected by a magnet, cannot be regarded as cathode rays which have passed through the glass, for that passage cannot, according to Lenard, be the cause of the different deflection of the rays. Hence I conclude that the X rays are not identical with the cathode rays, but are produced from the cathode rays at the glass surface of the tube.

13. The rays are generated not only in glass. I have obtained them in an apparatus closed by an aluminum plate 2 mm. thick. I purpose later to investigate the behavior of other substances.

14. The justification of the term "rays," applied to the phenomena lies partly in the regular shadow pictures produced by the interposition of a more or less permeable body between the source and a photographic plate or fluorescent screen.

I have observed and photographed many such shadow pictures. Thus, I have an outline of part of a door covered with lead paint; the image was produced by placing the discharge tube on one side of the door, and the sensitive plate on the other. I have also a shadow of the bones of the hand, of a wire wound upon a bobbin, of a set of weights in a box, of a compass card and needle completely inclosed in a metal case, of a piece of metal where the X rays show the want of homogeneity, and of other things.

For the rectilinear propagation of the rays, I have a pin hole photograph of the discharge apparatus covered with black paper. It is faint, but unmistakable.

15. I have sought for interference effects of the X rays, but possibly, in consequence of their small intensity, without result.

16. Researches to investigate whether electrostatic forces act on the X rays are begun but not yet concluded.

17. If one asks, what then are these X rays? Since they are not cathode rays, one might suppose, from their power of exciting fluorescence and chemical action, them to be due to ultra violet light. In opposition to this view a weighty set of considerations presents itself. If X rays be indeed ultra violet light, then that light must possess the following properties:

(a) It is not refracted in passing from air into water, carbon bisulphide, aluminum, rock salt, glass or zinc.

(b) It is incapable of regular reflection at the surfaces of the above bodies.

(c) It cannot be polarized by any ordinary polarizing media.

(d) The absorption by various bodies must depend chiefly on their density.

That is to say, these ultra-violet rays must behave quite differently from the visible, infra-red and hitherto known ultra-violet rays.

These things appear so unlikely that I have sought for another hypothesis.

A kind of relationship between the new rays and light rays appears to exist; at least the formation of shadows, fluorescence, and the production of chemical action point in this direction. Now it has been known for a long time that, besides the transverse vibrations which account for the phenomena of light, it is possible that longitudinal vibrations should exist in the ether, and, according to the view of some physicists, must exist. It is granted that their existence has not yet been made clear, and their properties are not experimentally demonstrated. Should not the new rays be ascribed to longitudinal waves in the ether?

I must confess that I have in the course of this research made myself more and more familiar with this thought, and venture to put the opinion forward, while I am quite conscious that the hypothesis advanced still requires a more solid foundation.

ROENTGEN PHOTOGRAPH OF A HUMAN HAND, SHOWING RING ON THIRD FINGER.

PROF. ROENTGEN'S DISCOVERY.

By A. A. C. SWINTON, in Nature.

THE newspaper reports of Prof. Roentgen's experiments have, during the past few days, excited considerable interest. The discovery does not appear, however, to be entirely novel, as it was noted by Hertz that metallic films are transparent to the cathode rays from a Crookes or Hittorf tube, and in Lenard's researches, published about two years ago, it is distinctly pointed out that such rays will produce photographic impressions. Indeed, Lenard, employing a tube with an aluminum window, through which the cathode rays passed out with comparative ease, obtained photographic shadow images almost identical with those of Roentgen, through pieces of cardboard and aluminum interposed between the window and the photographic plate.

Prof. Roentgen has, however, shown that this aluminum window is unnecessary, as some portion of the cathode radiations that are photographically active will pass through the glass walls of the tube. Further, he has extended the results obtained by Lenard in a manner that has impressed the popular imagination, while, perhaps most important of all, he has discovered the exceedingly curious fact that bone is so much less transparent to these radiations than flesh and muscle, that if a living human hand be interposed between a Crookes tube and a photographic plate, a shadow photograph can be obtained which shows all the outlines and joints of the bones most distinctly.

Working upon the lines indicated in the telegrams from Vienna, recently published in the daily papers, I have, with the assistance of Mr. J. C. M. Stanton, repeated many of Prof. Roentgen's experiments with entire success. According to one of our first experiments, an ordinary gelatinous bromide dry photographic plate was placed in an ordinary camera back. The wooden shutter of the back was kept closed, and upon it were placed miscellaneous articles such as coins, pieces of wood, carbon, ebonite, vulcanized fiber, aluminum, etc., all being quite opaque to ordinary light. Above was supported a Crookes tube, which was excited for some minutes. On development, shadows of all the articles placed on the side were clearly visible, some being more opaque than others. Further experiments were tried with thin plates of aluminum or of black vulcanized fiber interposed between the objects to be photographed and the sensitive surface, this thin plate being used in place of the wood of the camera back. In this manner sharper shadow pictures were obtained. While most thick metal sheets appear to be entirely opaque to the radiations, aluminum appears to be relatively transparent. Ebonite, vulcanized fiber, carbon, wood, cardboard, leather and slate are all very transparent, while, on the other hand, glass is exceedingly opaque. Thin metal foils are moderately opaque, but not altogether so.

As tending to the view that the radiations are more akin to ultra-violet than to infra-red light, it may be mentioned that a solution of alum in wafer is distinctly more transparent to them than a solution of iodine in bisulphide of carbon.

So far as our own experiments go, it appears that, at any rate without very long exposures, a sufficiently active excitation of the Crookes tube is not obtained by direct connection to an ordinary Rhumkorff induction coil, even of a large size. So called high-frequency currents, however, appear to give good results, and our own experiments have been made with the tube excited by current obtained from the secondary circuit of a Tesla oil coil, through the primary of which were continuously discharged twelve half-gallon Leyden jars, charged by an alternating current of about 20,000 volts pressure, produced by a transformer with a spark gap across its high pressure terminals.

For obtaining shadow photographs of inanimate objects, and for testing the relative transparency of different substances, the particular form of Crookes tube employed does not appear to greatly signify, though some forms are, we find, better than others. When, however, the human hand is to be photographed, and it is important to obtain sharp shadows of the bones, the particular form of tube used and its position relative to the hand and sensitive plate appear to be of great importance. So far, owing to the frequent destruction of the tubes, due to overheating of the terminals, we have not been able to ascertain exactly the best form and arrangement for this purpose, except that it appears desirable that the electrodes in the tube should consist of flat and not curved plates, and that these plates should be of small dimensions.

A photograph of a living human hand was exposed for twenty minutes through an aluminum sheet 0·0075 in thickness, the Crookes tube, which was one of the kind containing some white phosphorescent material (probably sulphide of barium), being held vertically upside down, with its lowest point about two inches above the center of the hand.

By substituting a thin sheet of black vulcanized fiber for the aluminum plate, we have since been able to reduce the exposure required to four minutes. Indeed, with the aluminum plate, the twenty minutes' exposure appears to have been longer than was necessary. Further, having regard to the great opacity of glass, it seems probable that where ordinary Crookes tubes are employed, a large proportion of the active radiations must be absorbed by the glass of the tube itself. If this is so, by the employment of a tube partly constructed of aluminum, as used by Lenard, the necessary length of exposure could be much reduced.

BRONZE MEDALS FOR THE CHALLENGER EXPEDITION.

WE take pleasure in publishing herewith an engraving (for which we are indebted to the Illustrirte Zeitung) of the beautiful bronze medals made for presentation to those who took part in the great work accomplished by the Challenger expedition (1872 to 1876), which was made by a staff of one hundred and ten scientists—many of them most prominent in their professions—under the leadership of Sir Wyville Thomson. The distance traveled in their voyage would have been more than equal to three times the circumference of the earth. They made many discoveries, and their collections were much finer than any ever made before. The government had these medals struck off as a proper mark of their appreciation of the work done by those who went on this expedition, and the results of their work were told in the "Report on the Scientific Results of the Voyage of H. M. S. Challenger," published by order of her Majesty's government.

BRONZE MEDALS FOR THE CHALLENGER EXPEDITION.

ABRAHAM'S OAK.

THE traveler in the Holy Land, after visiting Jerusalem and Bethlehem, generally goes down to Hebron, which is situated to the south of these two cities.

Among the curiosities of the country, the guides do not fail to show him, between Ain-Devoneh and Hebron, the place called Ramat El-Khalil ("Eminence of the Friend of God"), where, according to Jewish and Mussulman tradition, Abraham, after separating from Lot, erected his tents. This place was then designated as "Oak of Mambre," because it was shaded by a fine oak tree that occupied a spot in the vicinity of the city of that name. According to the Scriptures, it was here that Abraham learned that Chadorlahomor, with three other kings, his allies, had just invaded Pentapolis, that he arranged the plan of the campaign whose result was the defeat of his enemies, and that he offered sacrifices to the Lord in order to thank him for the aid that he had given him. It was then, as we know, that the Lord appeared to him in a dream and promised him to multiply his race like the stars, etc. Again, it was near the oak of Mambre that Sarah, who was barren, gave Hagar to her husband as a wife, that Abraham, who had entered upon his ninety-second year, renewed the covenant that he had made with the Lord, and that he had the honor of receiving God himself, under the form of three angels, who announced to him that in the following year his wife Sarah, although of advanced age, would present him with a son.

Finally, it was at the same place that Jacob, upon his return from Mesopotamia, went to find his old father Isaac, who was a hundred and four years old and who died shortly afterward.

It is not surprising that, later on, Ramat El-Khalil did not remain a place of veneration for Jews and Christians solely. The pagans themselves had altars there, and at the beginning of our era there was established a fair which Constantine swept away with the rest and replaced with an oratory.

The circumference of this celebrated tree, at the place where it is of the least diameter, is to-day 23 feet, and the height of the trunk is scarcely more than 6. The large branches ascend, but the crown descends low enough to allow a person to reach it. The longest branches extend to a distance of 90 feet. The tree has become the property of the Russians, who have surrounded it with a wall of an average height of 3 feet and a circumference of 65. Its guardian lives in a little house in the vicinity; but, in spite of his attention, the tree is falling into decay. One of its finest branches has already completely withered and fallen. It is doubtless this that we remark at the foot of the tree, to the right of our engraving.

Now, is this tree really that of Abraham? Lievin de Hamme, a Franciscan brother, whose writings upon the Holy Land are authoritative, doubts it. St. Jerome, in fact, expressly states that the oak was "still to be seen" in the reign of Constantine, and in the time of his own childhood (beginning of the fourth century). He seems, therefore, to speak of it as a thing that had disappeared. It is probable that the oak that is admired to-day is the same as the one that is described by Daniel, the Russian Igoumene (who visited Hebron toward 1113), and which he believed, moreover, to be that of Abraham.

"The aspect of it is superb," says he, "although it is not very tall. It is knotty, branched and loaded with acorns. Its branches incline toward the earth. I measured it with my arms and found it to be 13 feet in circumference. The height of the trunk up to the branches is about 10 feet."—La Nature.

ABRAHAM'S OAK, NEAR HEBRON, PALESTINE.

ON MOUNTAINEERS AND MOUNTAINEERING.

By EDWARD WHYMPER, in Leisure Hour.

MONSIEUR HORACE BENEDICT DE SAUSSURE was not a mountaineer, and did not pretend to be one; but his ascent of Mont Blanc gave an impetus to mountain exploration, and, unwittingly, he started the fashion for mountaineering. No sooner did he return to Chamonix than a tourist who was there went off and followed De Saussure's track. He was almost the first of the mountaineering race. The Genevese philosopher ascended the mountain to make physical, meteorological, and geological observations; Colonel Beaufoy went up for the sake of sport, to amuse himself.

For a considerable time mountain climbing for the sake of amusement made little progress. The fact was that those who indulged in it knew absolutely nothing of the mountaineer's art; they could not do without professional aid, and they found that professional assistance was expensive. In the twenty-five years after Mont Blanc was conquered there were only half a dozen other ascents, and the persons who went up had to be nursed and cared for like so many children. Even the professional guide went about in those days in a fashion which would now be thought absurd. The ice ax was almost unknown, and in order to overcome difficulties he had to avoid or circumvent them. During the lifetime of De Saussure two engravings were executed under his direction showing the manner in which he and his troop of twelve guides went to the Col du Geant and back again.

In the engraving which shows them descending they are not using a rope, and are wandering about like a flock of sheep. The whole of the party are employing alpenstocks—not ice axes—and for the most part are holding them improperly. They are endeavoring to prop themselves up with them in front, instead of leaning upon them behind, as they should do. M. De Saussure (who is last but one on the left) is about to harpoon one of his own feet, and if he continues to hold the implement in that manner, in the course of the next few yards must infallibly tumble head over heels. De Saussure went about on his mountain expeditions in a long tailed silk coat, with enormous buttons. The coat which he is said to have worn on his ascent of Mont Blanc is preserved at the family house at Genthod, near Geneva; and, whether it is the identical coat or not, it agrees fairly well with the garment in which he is represented in the engraving.

From time to time some of the great Alps were overcome. The Jungfrau (13,671 feet) was conquered in 1811; but after that there was a long interval before another considerable ascent was made. In 1840 the attention which was given to the motion of glaciers by Agassiz, Desor, Studer and others, and the speculations which they indulged in as to the manner of the formation and progression of glaciers, excited curiosity and indirectly induced idlers to visit the Alps; and a little later, the labors of Prof. Forbes in the same field, and especially the excellent map of the Mer de Glace and its tributary glaciers that he published in 1843 (which still is not superseded), exerted a more potent influence. It is now nearly forgotten that the rival glacier theories of these men of science excited an extraordinary degree of warmth both in professional and non-professional circles. There were cliques and factions that took sides, and squabbled and almost fought over the formation and motion of glaciers. The late Mr. John Ball gave the following amusing account of what he heard some years afterward one evening at the Grimsel Hospice. "I perceived," said he, "by the louder tones of my companions that they were engaged in some rather angry discussion, and, as it became impossible not to hear, my attention was at length fixed by their conversation. The discussion amused me so much that I made a note of it.

"'Then I think we had better separate; after this it is impossible for us to go on together.'

"'With all my heart; the less I see of you for the future, the better pleased I shall be.'

"'Very well; you can go whichever way you please in the morning, and I shall go in the opposite direction.'

"'It's all alike to me, so long as I get rid of your company.'

"'Ah! I always suspected you.'

"'What for, I should like to know?'

"'I remember well what you said one day in Heidelberg.'

"'And what did I say in Heidelberg?'

"'Here the voices fell, and for a while I heard nothing distinctly. My curiosity was excited, and as the voices rose again I listened, and found that the matter of dispute was neither of the common topics—politics or religion—but the theory of glaciers. One held what was then the orthodox faith at Heidelberg—the views published by Agassiz—while the other spoke of them and their author in the most irreverent tone, I fear even calling the latter a humbug."

About this time a Chamoniard came to the front, a man of unusual intelligence, an excellent mountaineer, who helped on the progress of mountaineering. Auguste Balmat, the guide in question, was associated with Prof. Forbes through all his work in the Alps, and for a number of years afterward took part in many prominent enterprises. He was equally efficient in escorting the Empress Eugenie across the Mer de Glace or in scaling the highest Alps. From his appearance no one would have suspected him to be an Alpine peasant; it would have been guessed sooner that he was a doctor, lawyer, or diplomatist. He became the favorite guide of Mr. Alfred (now Mr. Justice) Wills and died in his arms. It was Auguste Balmat who led the future judge to the summit of the Wetterhorn.

But before this stirring episode occurred another person gave a far greater stimulus to mountaineering than all who had preceded him. Mr. Albert Smith, a struggling litterateur, conceived the idea that an ascent of Mont Blanc, illustrated by dioramic views, might be made an exceedingly popular "entertainment," and he did not deceive himself. So popular did he make it that it would, I imagine, still be running if Albert Smith were still alive. Until his time the ascent of Mont Blanc was usually looked upon as a very serious business. Men commonly made wills before starting for it, and wrote heavy accounts of the dangers of the enterprise when they came down. Albert Smith invented a new treatment. In his hands the whole thing was a joke—a piece of sport. He made merry over his troubles, jested at the funny persons he met, and laughed at everything. He sent multitudes of people to the Alps to play who would never have gone there to work. From the account which he himself has given, it appears that he was smitten with a fancy for Mont Blanc at a very early age. When he was ten years old he had a little book given to him at the Soho Bazar, called the Peasants of Chamonix, which told the story of Dr. Hamel's attempt to reach the summit of Mont Blanc in 1820. On this occasion three lives were lost through disturbing new fallen snow. This little twaddly book, which was published for the delectation of children, made a deep impression upon Albert Smith. "I do not think," he said, "that the Pilgrim's Progress stood in higher favor with me," and he eventually produced a small moving panorama

of the horrors pertaining to Mont Blanc. "This I so painted up and exaggerated in my enthusiasm, that my little sister—who was my only audience, but a most admirable one—would become quite pale with fright."

In 1838, when he was twenty-two years old, Albert Smith went to Chamonix, and shortly after his return he thought he "could make a grand lecture about the Alps. I copied," he said, "all my pictures on a comparatively large scale—about three feet high—with such daring lights and shadows, and streaks of sunset, that I have since trembled at my temerity as I looked at them; and then, contriving some simple mechanism with a carpenter to make them roll on, I produced a lecture which in the town" (Chertsey) "was considered quite a 'hit.' . . . For two or three years, with my Alps in a box, I went round to various literary institutions. . . . I recall these first efforts of a showman—for such they really were—with great pleasure. I recollect how my brother and I used to drive our four wheeled chaise across the country, with Mont Blanc on the back seat."

In 1851 he carried out his long cherished desire, and attained the summit of Mont Blanc, and nine months afterward produced at the Egyptian Hall, Piccadilly, an entertainment descriptive of the ascent, which "took the world by storm, and became the most popular exhibition of the kind ever known." The effect was immediate. Whereas in the sixty-four years from 1786 to the end of 1850 there had been only fifty-seven ascents of Mont Blanc, in the six following years (1852-57) there were sixty-four ascents. The taste for mountaineering spread. Monte Rosa (15,217 feet) was conquered in 1855; the Grand Combin (14,163) and the Monch (13,438) in 1857; the Eiger (13,045) and Dom (14,941) in 1858. The men who went regularly to the Alps for the sake of mountaineering now formed quite a numerous body, and this led to the foundation of the Alpine Club in 1858. Two years later the members of this society published accounts of some of their excursions in a volume under the title of "Peaks, Passes and Glaciers," and this again caused the passion for mountaineering to increase. In the next half dozen years the conquest of the Alps was practically completed, as the following table, giving the dates of first ascents, will show:

Aletschhorn (13,803 feet)	1860
Lyskamm (14,889 feet)	1861
Weisshorn (14,804 feet)	1861
Schreckhorn (13,394 feet)	1861
Dent Blanche (14,318 feet)	1862
Dent d'Erin (13,715 feet)	1863
Pointe des Ecrins (13,462 feet)	1864
Rothhorn (13,855 feet)	1864
Aiguille Verte (13,541 feet)	1865
Gabelhorn (13,363 feet)	1865
Matterhorn (14,705 feet)	1865

From 1786 to 1859 only nine of the great peaks of the Alps were ascended, while in the six years following the publication of "Peaks, Passes, and Glaciers" nearly all that remained were conquered, and these latter naturally included some of the loftiest and most difficult ones. The sad fate of Michel Croz—one of the finest mountaineers of his own or of any period—and of the others who perished with him on the first ascent of the Matterhorn, though creating a profound impression at the time, seemed to stimulate rather than to repress the development of mountaineering.

On looking back to the early days of mountain climbing one cannot but feel surprised that our forerunners so seldom came to grief. They were entirely unacquainted with what might happen to them above the snow line, and rarely employed either rope or ice ax. Indeed, until the last five and thirty years, or thereabout, nearly all amateurs were unprovided with ice axes, and used the primitive alpenstock. De Saussure and Albert Smith made their ascents of Mont Blanc with alpenstocks. Professor Forbes, in referring to rope and "hatchet," says, "The former we never used, and the latter rarely." From the narratives in the first series of "Peaks, Passes, and Glaciers," published in 1860, it would appear that most, if not all, of the amateurs concerned with the excursions therein described went about without ice axes, and sometimes there was no ice ax either with the guides or tourists.

The desirability of having some stick or support is soon felt on a mountain. When a man who is not a born mountaineer gets upon a really steep slope, he speedily finds out that walking is an art, and wishes he could be a quadruped or a centipede, or anything except a biped; but, as there is a difficulty in satisfying these natural desires, he ultimately procures an alpenstock and turns himself into a tripod. The alpenstock acts as a third leg, the principal use of which is to extend one's base; and when the beginner gets this well into his head he finds his confidence largely increased. The length of the alpenstock should never exceed that of the person who carries it. It should be made of ash, of the very best quality; and it should be strong enough to support your weight when it is suspended at its two extremities. Unless shod with an iron point, it can scarcely be termed an alpenstock. My alpenstock has a long tang running into the wood, is supported by a riveted collar, and has a blunt though sharp point.

No one can say who invented alpenstocks. Poles shod with iron were called by this name hundreds of years ago. Josias Simler, writing on the Alps in the middle of the sixteenth century, says: "Precipitous and rugged paths further increase the difficulty of Alpine paths, and particularly if the tracks are covered with ice, for which reason travelers and shepherds, as well as the hunters who roam over the highest mountains, provide for their safety by various precautions. . . . In some places they use staves tipped with an iron point, and, resting their weight on them, are in the habit of ascending and descending steep slopes. These staves they call alpenstocks."

The primitive alpenstock is now wellnigh abandoned, and the ice ax has taken its place. It was not, however, until after 1860 that the use of the ice ax became general, even among professional mountaineers. The early form was that of an ax or hatchet, with a short handle. The greater part of these antique weapons have long since gone the way of old iron; and the implements which have been gradually evolved, and which replace the old form, usually more or less resemble that represented in the annexed figure, and are not axes at all, properly speaking. The manufacture of these articles has now become a regular branch of industry, and there are many ice ax makers in the Alps.

The practice of binding all the members of a party together by a rope when traversing snow-covered glaciers or steep slopes has become a regular practice in the course of the last fifty years, and it is now the established rule to do so; though independent people often protest against it, on the ground that it hampers their movements. It may be admitted that it is irksome to be bound one to another, and that, when tied together, liberty of movement is lessened; but experience shows that the plan has value, and, so far from throwing the rope on one side because its employment is irksome, in late years when traversing snow-covered glacier I have sometimes doubled the rope, and in descending steep places have used a looped rope attached to rocks in addition to the rope binding man to man. The Matterhorn accident of 1865 could not have occurred if this procedure had been adopted.

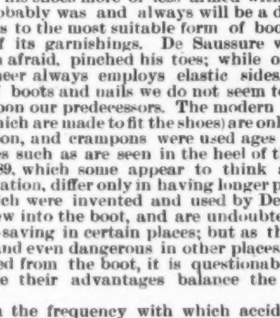
Ice ax and rope are now considered indispensable items in a mountaineer's equipment, but of other gear

WHYMPER'S ICE AX (1864-1895.)

he requires little. From the earliest days of mountaineering it was recognized that a man must be well shod, and have his shoes more or less armed with nails; but there probably was and always will be a diversity of opinion as to the most suitable form of boot and the nature of its garnishings. De Saussure wore shoes, and, I am afraid, pinched his toes; while one modern mountaineer always employs elastic sides. In the matter of boots and nails we do not seem to have advanced upon our predecessors. The modern "climbing irons" (which are made to fit the shoes) are only a variety of crampon, and crampons were used ages ago; while the spikes such as are seen in the heel of the boot on page 16789, which some appear to think are a modern innovation, differ only in having longer points from those which were invented and used by De Saussure. They screw into the boot, and are undoubtedly useful and time-saving in certain places; but as they are unsuitable and even dangerous in other places, and must be removed from the boot, it is questionable if upon the whole their advantages balance the disadvantages.

Though the frequency with which accidents have happened in recent years to people engaged in mountaineering must have been remarked by many, few perhaps will be prepared for the list which follows of persons who have lost their lives in this particular "sport." The list may be studied with profit, as it clearly indicates various things which should not be done by people who go mountaineering.

February 28, 1864. On the Haut de Cry (canton Valais). Two lives lost through attempting to traverse a slope when the snow on it was in an unfit condition. The party started an avalanche, and two were smothered in it. [This closely resembles the Hamel accident on Mont Blanc, in 1820.]



SPIKED SHOES WORN BY DE SAUSSURE.

(Preserved at Genthod.)

August 9, 1864. In descending Mont Blanc, a young porter who was unroped, and going in advance of his party, walked into a crevasse before the eyes of the others. He fell at least 100 feet, and his body was not recovered.

July 14, 1865. On the Matterhorn. While descending, Mr. Hadow slipped on rocks mixed with ice, fell against and upset his guide, Michel Croz, and the two falling dragged the Rev. C. Hudson and Lord Francis Douglas after them. All four were killed.

July 23, 1865. On the Riffelhorn. Mr. K. Wilson, while attempting to climb by himself, slipped, and was killed on the spot.

July 27, 1865. On Monte Rosa. Messrs. H. and J. Bailey, with three guides and two porters, when attempting to climb this mountain, shortly after snow had fallen heavily, started an avalanche, and came down with it. One of the porters was buried six feet deep and was suffocated.

August 23, 1865. On the Titlis. Herr Hupner, of Dresden, when on the upper part of the mountain, slipped on an ice slope, and dragged down a guide, to whom he was tied. They fell about 800 feet, and were killed on the spot.

August 23, 1866. On Mont Blanc. Sir George Young and two of his brothers ascended Mont Blanc without guides. In descending, one of them slipped, and dragged the others down with him. They slid for some distance, fell over a precipice 15 or 20 feet high, slid a little further, and then stopped in soft snow. The youngest of the party pitched on his head and broke his neck.

October 13, 1866. On Mont Blanc. Captain Arkwright, with the guides Michel Simond and Sylvain Couttet, and two porters, attempted to ascend Mont Blanc by Jacques Balmat's original route.* When a little above the Grand Plateau an avalanche fell on them. Captain Arkwright, Simond, and the two porters were carried away and killed on the spot.

July 27, 1869. On the Schreckhorn. The Rev. J. M. Elliott, when near the summit of the mountain and unroped, sprang from some snow on to some rocks, slipped, and fell about 1,000 feet. Was killed on the spot.

September 15, 1869. On the Lyskamm. Mr. Chester took a dog up the mountain, and in going to look after the animal he slipped, fell several hundred feet, and broke his neck.

September 6, 1870. On Mont Blanc. An entire caravan of eleven persons perished near the summit. Bad weather was encountered. Five bodies only were recovered.

December 4, 1871. Near Mentone. Rev. R. Crosse, while botanizing, dislodged a rock, which fell on and crushed him.

July 24, 1872. On the Jungfrau. Two guides, named Von Allmen and Johann Bischoff, were swept away and killed by an avalanche, in a place where avalanches were known to occur.

September 14, 1873. On the Glacier du Geant. Professor Fedchenko, surprised by bad weather, died from exhaustion.

August 31, 1874. On the Italian side of Mont Blanc. Mr. Marshall, with the guide Johann Fischer, at midnight, broke through a snow bridge over a crevasse. Both were killed on the spot. The second guide also fell in, but escaped with slight injuries.

August 28, 1876. On the Felikjoch. Messrs. Hayman and Johnson, with the guides Ignatz and Franz Sarbach, lost their way in a fog; and, when off the right track, were carried away by an avalanche. Mr Johnson and F. Sarbach were killed on the spot, and Mr. Hayman died afterward from the effects of the accident.

June 7, 1877. In Dauphine. Mons. Cordier (aged 21), while glissading down a snow slope, tumbled through a hole in it, and was drowned in a torrent underneath.

September 6, 1877. On the Lyskam. Mr. W. Lewis and Mr. Paterson, with the brothers Nicolas, Johann, and P. J. Knuble, broke through a snow cornice, fell for about 1,200 feet, and were all killed on the spot.

August 14, 1879. On the Matterhorn. Dr. W. Moseley, when at the height of about 13,000 feet, and unroped, endeavored to vault over a rock, slipped, fell about 2,000 feet, and was killed on the spot. [An accident similar to that on the Schreckhorn in 1869.]

July 18, 1880. On the Lauteraarjoch. Dr. Haller, with the guides Peter Rubi and F. Roth, fell through a snow bridge over a large crevasse and were all lost.

July 25, 1880. In the Zillerthal. Herr Welter, walking unroped on a glacier, fell into a crevasse and perished.

August 8, 1881. On the Italian side of Monte Rosa. Sig. Marinelli and two guides were killed by an avalanche. Avalanches were known to occur somewhat frequently on that part of the mountain.

September 4, 1881. Near Grindelwald. Mr. H. Latham, when climbing alone, slipped and was killed on the spot.

July 19, 1882. On the Aig. Blanche de Peteret (Italian side of Mont Blanc). Professor J. Balfour and J. Petrus (guide) fell a considerable distance when roped together, and were killed on the spot. The exact cause of the accident was not ascertained.

August 3, 1882. On the Wetterhorn. Mr. W. Penhall, and A. Maurer (guide) started when the mountain was in an unfit condition, were surprised and carried down by a small avalanche, and were killed on the spot.

August 12, 1882. On the Dent Blanche. Mr. W. E. Gabbett, with J. M. Lochmatter and his son (guides), fell about 2,000 feet, and were killed on the spot. The exact cause of the accident was not ascertained, but it is certain that one or more slipped.

August 15, 1882. On the Dundengrat. Herr Rutte, in jumping down about 15 feet, slipped and fell over a precipice. Died shortly afterward.

August 25, 1883. On Piz Bernina. A French traveler and two guides broke through a snow bridge over a crevasse, and fell to the bottom of it. The tourist was killed on the spot.

July 11, 1884. On the Grandes Jorasses. Mons. Guttinger of Geneva, when in the company of two guides (who warned him to conceal himself), neglected their advice, and was struck by falling rocks. He died shortly afterward.

July 23, 1884. On the Widderstein. Herr Henle of Wurzburg slipped on snow, and, striking rock, was killed on the spot.

July 29, 1884. Near Pontresina. The Rev. C. Reed slipped and fell over a high rock, fracturing his skull in such a manner that death was instantaneous.

June 28, 1885. In Styria. Two Germans without guides slipped while rock climbing, and fell about 700 feet. Both were killed on the spot.

July 4, 1885. Above the Glacier d'Argentiere. The Abbe Chifflet and two guides of Chamonix fell while mounting a slope above the glacier, and were all killed outright. The exact cause of the accident was not ascertained.

August 1, 1885. On the Col du Géant. Mario Rey (a boy 17 years old) dislodged a bowlder when near the summit of the pass, and was carried down with it about

* See the Leisure Hour, August, 1895.

500 feet. His body was recovered with difficulty, being covered by a great mass of stones.

August 6, 1885. On the Meije (in Dauphine). Herr E. Zsigmondy fell more than 2,000 feet through his rope slipping off a tooth of rock around which he had passed it. Killed on the spot.

August 31, 1885. Near Zermatt. Mr. J. Devas slipped while climbing alone, fell about 140 feet, fractured his skull, and died shortly afterward.

June 26, 1886. On the Gross Glockner. The Marquis de Pallavicini, Mons. H. Crommelin, and two of the best of Tyrol guides, were all killed by breaking through a snow cornice.

August 18, 1886. On the Matterhorn. Mr. F. Borckhardt (aged 48) died from fatigue and exposure to bad weather.

July 15 (?), 1887. On the Jungfrau. Six Swiss tourists (without guides) perished near the top of the mountain. They fell about 650 feet, and were all found dead, close together. The exact cause of the accident (which happened during bad weather) is not known.

July 19, 1887. On the Pers Glacier. The Rev. D. Wheeler walked into a crevasse, and was drowned in water at the bottom.

August 2, 1887. Pic d'Orpillous (Dauphine). Mons. J. Geny of Nancy, when a short distance below the summit, dislodged a bowlder, which fell upon and cut the rope by which he was attached to his guide. M. Geny fell a considerable distance and was killed on the spot.

Besides the above fatal accidents (which occurred above the snow line), twenty-one other lives were lost below the snow line in 1887, nearly all through slipping.

July 25, 1888. On the Dachstein. When descending this mountain, unroped, Dr. Zeidler slipped on a snow slope and fell over a precipice, dragging down his friend, Herr Tannheiser, who tried to assist him. The latter was killed on the spot, and Zeidler died shortly afterward.

August 11, 1888. On the Dent du Midi. Mr. R. F. Ball, while glissading down this mountain, lost command of his movements, fell some distance and was killed on the spot.

August 14, 1888. On the Weisshorn. Herr G. Winkler of Munich set out to climb this mountain alone, and did not return. His cap was found in a recent avalanche, which it was supposed had carried away and entombed him.

August 20, 1888. On Monte Cristallo. Michael Innerkofler (a Tyrol guide), along with two other persons roped together, broke through a snow bridge over a crevasse, and fractured his skull against the walls of ice. The others escaped injury.

A number of other fatal accidents occurred in 1888 on the lower Alps through slipping.

August 13, 1889. On the Zanfleuron Glacier. Mons. Morel of Lausanne started with a guide named Gandin. Shortly after they got on the glacier, the guide broke through a snow bridge and fell into a crevasse. M. Morel was able to drag him nearly out, but his strength was not equal to pulling him through the remains of the snow bridge; and he fixed the rope (which was still attached to the guide) round his alpenstock driven in the snow, and went back for assistance. The body was not recovered until August 16, and was found to be only three feet from the surface, dangling from the rope.

June 24, 1890. On the Similaun, in the Oetzthal, Herr Poppe, from Saxony, and his guide broke through a snow cornice near the top and were both killed.

July 31, 1890. On the Kitzsteinhorn. Dr. E. Mayer, of Vienna, and his son, with their guide, Scherunthaler, were all found dead on this mountain. It is presumed that one or more slipped, but the exact cause of the accident is unknown.

August 12, 1890. On the Col du Géant. The guide, G. Brunod, while his party was stopping on the top of the pass, went a few feet aside to get some water from a neighboring trickle. He slipped, fell 1,000 feet, and was killed on the spot.

August 16, 1890. In the Maderanerthal. Mr. A. Macnamara slipped and fell some distance on ordinary slopes and died almost immediately.

August 18, 1890. On Mont Blanc. Count Umberto di Villanova, with Jean Joseph Maquignaz and A. Castagneri as guides, and with two porters, started to ascend Mont Blanc from the Italian side. The entire party disappeared. Their tracks were followed to a great height, and they then suddenly terminated at the commencement of a very narrow ridge. It is conjectured that they were surprised at this place by bad weather which set in suddenly, and were blown over the ridge. Down to the present time none of the bodies have been recovered.

August 25, 1890. On the Matterhorn. The guide, Jean Antoine Carrel, died from fatigue, cold and want of food while bringing Signor Sinigaglia, of Turin, down the southern side of the mountain during exceptionally bad weather. This is, perhaps, the only example that can be quoted of a guide losing his life under similar circumstances.

September 13, 1890. On the Matterhorn. Herr Goehrs, of Strasburg, and his guides, Graven and Brantschen (all young men), fell about 2,000 feet down the eastern face of the mountain, and, of course, were killed on the spot. The cause of this accident is not known.

June 28, 1891. On the Roche Melon. Signor L. Lanza, of Turin, slipped on a slope of ice covered with snow when about 100 feet from the top, fell about 1,600 feet and was killed on the spot.

Two months afterward a colonel of Italian engineers started alone to ascend the same peak and has not since been heard of.

July 31, 1891. Near Pontresina. Herr Weber Imhof, of Winterthur, while returning in the dark from an ascent of the Piz Bernina, tripped himself up and fell head first about 20 feet into some rocks. He died on the next day.

August 13, 1891. Becco di Mezzodi (near Cortina). Herr W. Behr, of, Hamburg, started to climb the peak alone. He did not return, and was found at the foot of a cliff 200 feet high with his skull smashed. Cause of accident is unknown.

July 25, 1892. On the Spiegelkogel. Father E. Zelnicek (a Cistercian monk) and his Tyrol guide, Raffeiner, lost their lives by breaking through a snow cornice.

August 18, 1892. On the Grivola. Herr Brock, of Berlin, with the guides, F. Bich and A. Proment, ascended this mountain and then disappeared. Their bodies were found on August 29, low down the peak, almost buried under rocks and snow. The cause of this accident is unknown.

September 6, 1892. On the Fünffingerspitze Herr E. Stücklen, of Stuttgart, with the guide, Jos. Innerkofler, started to climb this mountain. They did not return and their bodies were found on the next day near the base of the peak. Cause of this accident is unknown.

July 28, 1893. On the Winnebachkogel. Herr Menzel, an Evangelical clergyman, from Erfurt, ascended this mountain alone, and left a card on the summit inscribed, "Hope to find a shorter way down." On the descent he fell on a slope of grass and slabs of rock and was killed on the spot.

August 7, 1893. On the Matterhorn. Andreas Seiler (aged nineteen) and J. Biner (a young guide of Zermatt), while climbing the southern side of the mountain, shot over the heads of a closely following party and fell down cliffs and precipices for about 1,600 feet, and were killed on the spot. Though the others were so close, the cause of the accident is not known. It is presumed that one or both slipped.

CLIMBING IRONS.

August 21, 1893. On the Schwarzenstein (in the Zillerthal). Herr Chaumontet ascended this mountain accompanied by a porter aged 65, who had never been on a glacier and carried no ax. As rope they had a piece about 15 feet long and a quarter inch thick. On the descent they had to cross a crevasse which was wide below, but at the surface was only about 10 inches across. Herr Chaumontet, who was a heavy man, stepped on the edge, the ice broke under him and he fell into the crevasse to a depth of 70 feet and was buried under a mass of snow. Body was recovered next day.

August 27, 1893. On the Aiguille Noire de Péteret (a pinnacle of Mont Blanc). Signor Poggi, of Milan, ascended this mountain with two Italian guides. In descending a stone about as large as a man's fist came whizzing down and dislodged other loose stones which fell upon the climbers. The guides were not seriously injured, but Signor Poggi was struck by a stone behind the ear and was killed on the spot.

September, 1893. On Mont Blanc. In the middle of September an Italian named Cumani attempted the ascent of Mont Blanc alone and has not since been heard of.

December 31, 1893. On Scafell. Dr. A. Milnes Marshall slipped on rocks, fell about 130 feet and was taken up dead.

September 6, 1894. On the Earingerspitze. Herr J. Pemsel, of Nuremberg, while climbing this mountain with three other persons, insisted upon going unroped. When within a short distance of the summit he suddenly let go his hold, slid down for about 65 feet and then fell over precipices about 1,300 feet more.

September 8, 1894. On the Marmolata. Herr W. Kahl (a Bohemian, aged twenty-six) and a guide (J. Villgrattner), when near the summit, dislodged fresh, powdery snow lying over old, hard snow, and came down in an avalanche. Both were killed on the spot.

EMILE REY'S BOOT (1894).

September 20, 1894. On the Zinal Rothhorn. Dr. P. Horrocks, with the guides, Joseph Marie Biner and Peter Perrn, of Zermatt, ascended this mountain. In descending Biner went first, Horrocks next and Perrn last. Perrn dislodged a rock and fell downward and the others did the same; but the rope with which they were tied caught in a cleft and pulled Biner up so violently that the rope parted and he was precipitated 2,000 feet on to a glacier beneath.

August 18, 1895. On Mont Blanc. Dr. Robert Schnürdreher, of Prague, while descending the Chamonix side with two Italian guides, attempted a glissade. They lost command of their movements and shot into a large crevasse. They were found 80 feet down in it a week later, all dead.

August 24, 1895. On the Aiguille du Géant. Mr. A. C. Roberts, with the guide, Emile Rey, of Courmayeur, ascended this peak. In descending they unroped. Rey was leading, and jumped, or allowed himself to drop, on to a small platform of rock covered with débris and slightly sloping. He slipped and fell several hundred feet in three bounds on to the glacier, shattering his head.

August 30, 1895. On the Trift Pass. Miss Sampson and Miss Growse crossed this pass from Zermatt with the guides, Louis Carrel and Anton Biener. They had got to the foot of the cliff on the Zinal side when they were assailed by falling rocks, and Miss Sampson was struck by one (which weighed perhaps 70 to 80 pounds) in the back. She expired about an hour afterward. [This accident is to be attributed to the party crossing the pass too late in the day and at a time when stones are known to fall habitually.]

If this list is examined, it will be found that a larger proportion of the fatalities have occurred through slipping than from any other cause. The first thing which should be done by a person who desires to go mountaineering should be to acquire the art of keeping on his legs—that is to say, of preserving his balance. To do so effectively requires long practice, and in this matter of detail it is seldom that even the most experienced amateurs approach the dexterity of native born professional mountaineers; not because they are less nimble and agile, or endowed with less physical strength, but because they have not acquired the art of accommodating their limbs intuitively to the ever-changing angles of rock, snow and ice which must necessarily be traversed. Those generally come nearest to the ideal who have had the advantage of passing their boyhood and youth among mountains.

The born mountaineer rarely slips; yet there are exceptions to the rule, as we saw in 1895, by the death of Emile Rey, a man famed for his strength and stability, who habitually used in his boots the spikes which are shown upon this page. It is, however, possible to pass a lifetime in mountaineering without getting into accidents.

There are guides living, and still in practice, who have been actively at work in the high Alps for thirty years and upward without mischance. Such facts are stronger recommendations than bushels of testimonials. Melchior Anderegg—prince of guides—retired a couple of years ago after having been in the front rank for forty years, during which time he scaled every principal peak in the Alps, with all sorts and conditions of men, and could say at the end of the time that he had never had an accident, no, "not even to a porter!" and he carries into his retirement the affection and good wishes of all who have known him. His employers, comrades and family all declare that he is "a dear old man."

ORIGINAL FORM OF WILD MAIZE.

By J. P. ROTHWELL.

A FEW months back the SCIENTIFIC AMERICAN contained an article in which it was pointed out that botanists were uncertain, or even positively ignorant, of the original wild forms of some cultivated grasses. Among others, maize is one that was then mentioned.

Though I cannot point out myself any wild grass that could be ancestral to maize, it may be the following notes will be of service to those engaged in the search. Their value lies in their being notes of observations made on atavism now ensuing upon careless treatment of grain in cultivation. Or, if better said, notes on reversions to less specialized forms than those first sown in Africa. Such reversions are generally regarded as showing some return toward types that were actually ancestral. If so, it will be by comparing atavic instances that the original form will be found.

The instances studied arose in this way. The Kalihari Desert of older maps, or British Bechuana Land, as it is now called more often, is a region of very uncertain rainfall. It is inhabited by Sechuan tribes, who are hereditarily lazy. Perhaps their undependable climate makes them so. But as it is, they, losing crops often, at best barely think it worth while to give much attention or labor to their fields. So, unless irrigation waters be available, seed once thrown in is mostly left to chance. Unirrigated crops, therefore, have to struggle against difficulties both necessary and unnecessary. First of these, a scarcity of water, which cannot be obviated; next, a scarcity of attention, which might be remedied. In result, the lowest quality of grain is produced, perhaps the lowest in the world, but it is the only quality which ever withstands the hardships of environment.

Native carelessness goes further still, however, in abetting reversion. Not only is the whole maize crop low in quality from bad cultivation; there is still another cause of rapid degradation to be found. And that is, that there is absolutely no attempt made to select grains for seeding. The contrary is the rule. At planting time the quantity needed for sowing is taken from the whole bulk; from the bulk just as it was stored. For storing, every grain, good or bad, is beaten from the cobs. In seeding, therefore, grains big, little, round, flat, or crooked, as chance may happen, get planted together without the least discrimination. Each seed in hand is thrown to the soil.

Reversion, under these circumstances, can only be expected, and it is observations on its effects that are here noted.

A highly specialized maize seed grows into one single straight stem. That stem has ovaries, snugly hidden, set close beside it, and pollen producers standing free at the upward termination of growth. That is the highest standard. Any plant not coming up to it is in some degree a failure, from the farmer's point of view. Further, it is in some degree a reversion, from the naturalist's standpoint. It is from the latter I glance at the matter.

If a beginning be made with slight failure, it will be easier to follow on that which is greater and more pregnant with meaning. So instances will be noted in that order. Lesser first, greater last.

The first of these fallings away from high standards, then, is to be noticed in an increase of length in footstalks of cobs. Next to this, the attachment of free leaves to such footstalks, the latter having lengthened still more. The leaves in this case are members partly liberated from the foliage usually aborted to make the cob's covering sheath. This class of atavism, continued further, results in the production of a distinctly

branched stem; and further still, in a lowering of the branching points, until side growth occurs only in stooling from just above the root. All stems are then nearly equal in height. This is well shown in 'striped maize," an ornamental Japanese variety, fashionable in gardens some twenty-odd years ago. The manner of growth then is that common to grasses.

But it is through reproductive organs that species are best recognized; ergo, that atavism may be best followed. In highest types the pollen bearer is exclusively masculine. In lower this is not so. Upon one branchlet of an otherwise male inflorescence, a single egg cell will throw out a fibril, and in time will develop into a grain. Such a grain is always small, rounded, and short, instead of being long and dentiform. That shape alteration is a falling away. In still further degradation, a pollen bearer will produce quite a number of inferior grains, in which event, perhaps two or three will be in close contact, when each will modify the form of the other by mutual compression. The organ that should be wholly male has taken on again, by reversion, a good deal of primitive femininity. Yet more. Atavism to this extent is always accompanied with the branching habit of stem. Ovaries are protruded on side stalks some few inches long, and sheath blades coincidently are both loose and little protective. With this stage of lowering, it is common for cobs to throw out an inch or so of pollen-bearing organs, as a terminal to the purely feminine part. And on cobs themselves there are many blank spaces.

Degradation on both the given lines can now be easily followed by the mind. If further continued, it obviously goes on to a reversion to a type having many branches stooling from one root. Each branch will bear at its end a spike carrying organs of both sexes. Each terminal spike will be both masculine and feminine in gender. The ripe grains produced would be rarely in contact.

From this reasoning, on observed facts, it is natural to conclude that the original wild maize was a common looking grass with broad leaves, and with branches that were many and straggling. In autumn each terminal would bear five or six scattered seeds, small, ill-looking, ill-nourishing; seeds obviously difficult to gather in quantity. A grass, then, having this characterization, is the one to be looked for in rediscovering the parent stock of modern maize.

CYPRIPEDIUM INSIGNE, WITH THE UPPER AND LOWER SEPALS SIMILARLY SPOTTED.

CYPRIPEDIUM WITH PELORIATED SEPALS.

PELORIA, or the development in a regular and uniform manner of parts that are usually irregular, is most common in the corolla. In the calyx, or outer whorl of the flower, it is less common. Still, we do not know how better to classify the flower of Cypripedium insigne exhibited by Mr. Tate at a recent meeting of the Royal Horticultural Society. The uppermost single sepal, and the lowermost, which consists of two in combination, were both characterized by the white tip and the purplish-brown spots that usually characterize the upper sepal only.

Other flowers on the same plant showed intermediate conditions, and it will be interesting in the future to note whether all the flowers will assume the characteristic coloration and spotting. Should they do so, the gain will be great.—The Gardeners' Chronicle.

A TELEPHONE line was recently installed from Biskra to Tuggurth, in the Desert of Sahara.

THE PEANUT PLANT.

"THE peanut plant does not produce a nut at all. It is a ground pea, and is called a nut because it has a nut-like shell. The plant blossoms in the air and sunlight, but after the blossom has fallen off, the stem upon which it was plows or punches itself into the ground several inches, where the seed portion of the flower begins to enlarge and develop into a pale yellow, wrinkled, curved 'pod,' with a slight drawing together in the middle. If the stem does not find its way into the ground within a day or two after the flower falls off, the stem dies. The surface of the pod is netted.

"The peanut has never been known to grow wild, and it is not known where it is native. A hundred years ago the peanut was a leading article of food in Africa, and the slave traders loaded their vessels with peanuts and the negroes lived on them on the voyage.

"It grows abundantly in Japan, China, and in all East India countries. It was not much cultivated in the United States until 1866. Their extended cultivation was the result of the war. Until then there had been large importations from Africa, but since 1870 this country has raised all it has used. Virginia, North Carolina and Tennessee produce most of the crop of the United States. Under good conditions, before the land has been 'exhausted' by raising the same crop too long, they can raise from fifty to one hundred bushels to the acre.

"The pea vines are better food for cattle than timothy hay and almost as good as clover. Peanut meal is good food for cattle. A bushel of good peanuts weighs about twenty-two pounds. The peanuts are plowed up rather than dug up. The plow turns up the soil and loosens the vine and pods from the earth, and they are then pitchforked out of the ground, the earth being carefully shaken from the plants. They are plowed up in the morning, pitched into rows soon after, and at night pitched into a stack about a pole, seven feet high. Rails are laid below the vines, so that the lower pods will not be pressed into the earth and be spoiled. The vines are so placed as to have the pods inward toward the pole, and a space is left for air next to the pole. On the top of the stack is hay or cornstalks, to keep out the rain.

"The stack is left from two to three weeks, and then women and children pick the good pods from the vines. This is slow work and quite expensive. Some farmers leave the vines two days after plowing before they are shaken out, and some make their stacks fourteen feet high. Some leave them in the stacks less than two weeks, and then put them in barns till they are ready to market them or have leisure to pick them.

"Some farmers pick them from the vines by machines. The pods are cleaned by machinery before being put in sacks. A sack holds four bushels. Peanuts well put up and kept in a dry place are good for many years.

"There are about 4,000,000 bushels of peanuts raised in the United States each year. The rest of the world raises five times as many as the United States, or 20,000,000 bushels.

"The peanuts are of four grades. The first three grades are for venders of roasted peanuts. The fourth is for confectioners for 'burnt almonds' or peanut candy.

"The American people pay $10,000,000 for peanuts, not to eat as food, but to nibble for fun."—The Journal of Education.

GUTTA PERCHA FROM LEAVES.

So far as known, gutta percha has up to the present time been obtained only by the tapping of those trees which yield the caoutchouc-containing sap. Since after the trunk has been thus bored several times the tree dies, this method threatens with extinction the rubber-producing forests. A Dutch chemist has, however, found that not only the bark of the tree contains the sought for sap, but also the leaves, and in relatively larger quantities than the stem. Consequently, in certain plantations only the foliage of the trees is used in obtaining gutta percha. Since the leaves may without injury to the tree be removed twice a year, the natives gather and dry them and send them by the shipload to France where they are extracted with carbon bisulphide, giving a much purer article than by the usual process. If this practice becomes general, a decline in the price of gutta percha may be expected.—Apotheker Zeitung, 10, 1895, p. 769.

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